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THE POPULAR SCIENCE MONTHLY.

CONDUCTED BY E. L. AND W. J. YOUMANS.

CONTENTS.

PAGE
I. Medical Quacks and Quackeries. By Dr. F. J. Shepherd.... 145
II. Recent Magnetic Storms and Sun-Spots. By Garrett P. Serviss. (Illustrated.)........ 163
III. Vivisection in the State of New York. By B. G. Wilder, M.D. 169
IV. Quartz: its Varieties and Formation. By Rev. J. Magens Mello, F. G. S........ 180
V. The Remedies of Nature.—Consumption (*Concluded*). By Felix L. Oswald, M. D........ 187
VI. A German View of the "Data of Ethics." By Friedrich von Baerenbach........ 195
VII. Cost of Life. By John Pratt........ 202
VIII. On Science-Teaching in the Public Schools........ 207
IX. The Chemistry of Cookery. By W. Mattieu Williams..... 214
X. Our Marriage and Divorce Laws. By Gordon A. Stewart.. 224
XI. Evolution. By H. H. Boyesen........ 237
XII. The Boundaries of Astronomy. II. The Nebular Hypothesis. By Robert S. Ball, F. R. S........ 239
XIII. Darwin and Copernicus. By E. Du Bois-Reymond........ 249
XIV. Whistling. By T. F. Thiselton Dyer........ 251
XV. Sketch of Prof. Benjamin Silliman, LL. D. (With Portrait.).. 259
XVI. Correspondence........ 267
XVII. Editor's Table: Science, Literature, and Theology.—Heber Newton and the Heresy-Hunters.—The Banquet to Dr. Holmes........ 268
XVIII. Literary Notices........ 273
XIX. Popular Miscellany........ 281
XX. Notes........ 287

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TESTED AND NOT FOUND WANTING.

The following is taken from *The Whispers of Peace*, published by Rev. S. H. Platt, A. M., at Southampton, N. Y. Mr. Platt has been using Compound Oxygen for some four years, and during that time has tested it in forty-one cases, the results of which he has voluntarily given to the public in his paper. Mr. Platt is well known among the Methodists, to which denomination he belongs, as a truth-loving and conscientious man. No question can, therefore, lie against the fairness of his report:

"TESTED AND NOT FOUND WANTING.

"Thirty years of close observation and study have convinced us that the science of medicine needs some great *vitalizer* adapted to the widest range of diseases, yet thoroughly practicable. For a long time we sought it in electricity, but for the masses that is an untamed colt—serviceable if it can be properly used. In the nature of the case, no drug can ever meet the requirements. *Four years of experiment* have led us to believe that it is found in the *Compound Oxygen* of Drs. Starkey & Palen.

"As we have been so severely condemned for advertising this article so largely, we submit the following facts to the judgment of our readers, and also to answer the numerous letters of inquiry that reach us concerning it.

"We have *personally* tested Compound Oxygen in forty-one cases, with the following results:

"Class I. *Cases recognized from the outset as incurable:* One uterine, three consumption, one diabetes, advanced stage; all greatly relieved.

"Class II. *Cases deemed as* POSSIBLY *curable:* 1. Deranged several years, excessive nervousness; much improved. 2 and 3. Bronchial consumption; one nearly cured, the other greatly helped but the disease rendered fatal by an accident. 4. Bronchitis, one lung useless; cured. 5. Constitutional debility, life-long; improved. 6. Consumption; cured. 7. Confirmed and increasing hallucinations; cured. 8. Neuralgia of optic nerve, gastric irritation, great nervous prostration; abandoned for want of proper instruction while at a distance.

"Class III. *Cases deemed probably curable:* 1. Bronchitis and hay-fever; bronchitis cured. 2. Gastric fever and prostration, inability to recuperate; cured. 3 and 4. General debility; greatly benefited. 5. Kidney disease and nervous debility; 'life saved.' 6. Persistent and harassing cough; cured. 7. Cough of twelve years' standing; cured. 8. Lung and heart disease; lungs cured and heart much improved. 9. Obstinate cough; cured. 10. Consumptive tendencies and cough; cured. 11. Cough and spermatorrhea; cough cured. 12. Nervous debility; cured. 13. Sciatic neuralgia, nervous prostration (life despaired of); cured. 14. Consumptive decline; 'saved.' 15. Bronchial and gastric irritation and extreme nervous prostration (life despaired of—could only take oxygen three seconds); cured. 16. Nervous debility and uterine troubles; greatly relieved. 17-20. Overwork; all helped immediately, though continuing the work. 21. Uterine difficulties, extreme nervousness and hallucinations; appetite improved immediately, but treatment unwisely abandoned lest it should increase stoutness. 22-24. Treatment not properly used. 25. Nervous debility from over-study; helped. 26. Debility, difficulty of breathing, strong hereditary consumptive tendencies; debility partly overcome, difficulty of breathing cured (still under treatment). 27. Liver complaint of many years, and nervous derangement; liver decidedly better. 28. Lung disease and dyspepsia; improved, but frequent absence from home interferes with the treatment.

"It should be observed—

"1st. *Most* of these were cases in which physicians, and other remedies, *had failed.*

"2d. Many of them were chronic.

"3d. In thirty-eight of the forty-one cases only one Treatment (two months) was used, and in no case more than two.

"4th. Many of the cases reported relieved or helped would undoubtedly have been *cured* by farther treatment, but financial reasons prevented. A number are still under *treatment.*

"5th. This statement of results is accurate to our personal knowledge.

"6th. These embrace *all the cases* under our own direction instead of being culled, as ordinary testimonials are, from hundreds or thousands of experiments.

"Knowing these facts, and knowing, moreover, that, according to the reports of a large Life Insurance Company of *causes of death* of its members during six months of the present year, every *fourth* person died of lung disease (and these, too, all *selected lives*), *we should deem ourselves false to the interest of our readers, and traitors to humanity, if we failed to make known such a boon for the suffering.*

"Now, if the Baltimore *Methodist* or *The Pioneer* can produce, from the records of any physician of any school, or from the history of any proprietary remedy, achievements equal to these, we proffer our columns for a like publicity; still the fact will remain *that they have maligned this agency of cure without adequate investigation of its merits.* Prejudice and prejudgments are as poor helps to editorial consistency as elsewhere in life."

To those who wish to inform themselves in regard to this new Treatment, we will send, *free of cost*, our "*Treatise on Compound Oxygen*," and our pamphlet, containing over fifty "*Unsolicited Testimonials;*" also, "*Health and Life*," our quarterly record of cases and cures under the Compound Oxygen Treatment, in which will be found, as reported by patients themselves, *and open for verification, more remarkable results in a single period of three months than all the medical journals in the United States can show in a year!*

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THE

POPULAR SCIENCE
MONTHLY.

JUNE, 1883.

MEDICAL QUACKS AND QUACKERIES.

By FRANCIS J. SHEPHERD, M. D.

JOHNSON defines a quack as "a boastful pretender to an art he does not understand," and perhaps the term is more often applied to boastful pretenders of the art of medicine than of any other.* Probably, ever since man acquired the faculty of articulate language, quacks and quackeries have flourished. In the ruder ages, man attributed all disease to the influence of evil spirits, and sought by various means to ward off or lessen their injurious and malevolent actions. Now, as an eminent physiologist has lately said, the controlling of unknown powers has always been a matter of some difficulty, and one which ordinary mortals with average ability could not successfully attempt; hence arose a class of specialists—men who, by their greater knowledge and cleverness, made others believe that they were able to cope with the unseen. These were the priests, and, without doubt, the first quacks. They supplied charms and potions, and made use of incantations, not only to cure, but to prevent disease. These services obtained for them great power and influence and increased wealth. The ancient Egyptians attributed all diseases to the anger of the gods. They worshiped Serapis as a medical divinity, and the cure of disease could only be accomplished through the intercession of this deity's priests. Thus the priests had the monopoly of medical practice, and their medical knowledge was jealously concealed from the vulgar; it was only divulged to those who with extravagant ceremonies, wonderful mummeries, and terrible vows of secrecy, were initiated into the Egyptian mysteries. It was thus that Pythagoras is supposed to have obtained the foundation of his medical knowledge and philosophy. Among the Israelites the priests had charge of the health of the people, and in time of plague and pestilence relied wholly on religious methods of cure. According to the accounts that have come down to us, these methods were most successful. In highly civilized Greece, priests, the direct descendants of Æsculapius, cured disease by mysterious ceremonies, music, offerings, fastings, and such like. In Rome, when a plague broke out, the priests endeavored to combat it by feasting the gods, or driving nails into the right wall of the Temple of Jupiter. The early Christian Church was strongly opposed to the progress of medicine. It believed that the power of curing disease had been transmitted from Christ and his apostles to their bishops and elders. They discarded altogether the use of medicinal agents, and healed the sick by prayer, the laying on of hands, and the anointing with oil. This form of treatment, being of the miraculous order, needed no knowledge of the nature of disease, or of the structure of the human frame. Heathen priests and physicians were regarded as sorcerers and dealers in witchcraft, and so were burned or otherwise put out of the way. For some centuries the monks monopolized all the medical practice and quackery. They made a good living, selling for large sums of money remnants of ancient martyrs, waters of holy wells, portions of the true cross, etc., as a protection against sickness, witchcraft, evil spirits, and other ills that flesh was heir to in those dark ages. They prayed to St. Anthony for inflammation, St. Valentine for epilepsy, St. Clara for sore eyes, St. Appolonia for toothache, St. Vitus for madness and poison, and so on.* It was not till after the breaking up of the powers of the priesthood by the Reformation, and the introduction of printing, that medicine began to escape from the grasp of quackery and made rapid strides toward the truth, perfecting knowledge of disease by accurate observation and the study of the human frame and its workings in health. That the emancipation of medicine from superstition did not immediately take place is evidenced by the wonderful hold the belief in the cure of scrofula by the royal touch had on the people, both medical and lay, for many years after the Reformation, nay, almost down to our own time. This most remarkable form of quackery, and one, according to

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* "'Quack' is said to be an abbreviated form of 'quacksalver,' which is derived from the Dutch *Kwabzalver*—from *Kwab*, a *wen*, and *Zalver*, an *ointment*."—*Notes and Queries.*

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* The Medical Rose offers a peculiar and very approved remedy for epilepsy. Advising the patient to stand upright, saying the Lord's prayer with the mouth wide open to prevent the first attack, and informing us that a lunatic, an epileptic, and a demoniac were the same, he gives the following sacrophysical directions: "When the patient and his parents have fasted three days, let them conduct him to a church. If he be of a proper age and in his right senses, let him confess. Then let him hear mass on Friday, during the fast of *quatuor temporum*, and also on Saturday. On Sunday let a good and religious priest read over his head in church the gospel which is read in September in the time of vintage, after the feast of the Holy Cross. After this, let the same priest write the same gospel devoutly, and let the patient wear it about his neck, and he shall be cured. The gospel is, 'This kind goeth not out but by prayer and fasting.'"—("Rosa Anglica," p. 78, edition 1491; ib., p. 415, edition 1595—quoted in Willcock's "Laws of the Medical Profession," p. 25, edition 1830.)

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some, peculiarly English in its origin, was exercised in England for nearly seven hundred years. Edward the Confessor was the first who touched for the king's-evil, and transmitted the gift to all his successors. His power was attributed not to his royalty but to his sanctity, and there "seemed little reason why his successors, who were, as a rule, no saints, should be so specially favored." The kings of France also claimed the right to dispense the gift of healing, and traced their right to Clovis. Queen Anne was the last to exercise this gift in England, and it is well known that she touched, among others, the celebrated Dr. Johnson, who was brought to the King by his mother on the recommendation of Sir John Floyer, a distinguished physician of Litchfield.* William III had too much sense to pander to the superstitious feelings of many of his subjects, and never employed the touch but once, and then he said, on laying his hands on the patient, "May God give you better health and more sense!" Queen Elizabeth was averse to the practice, but extensively performed it. Charles II excelled all his predecessors and successors in this ceremony. During his reign he touched nearly one hundred thousand persons for the evil. One year (1682) over eight thousand sufferers were subjected to his sacred touch. The patients were first examined by the King's surgeons, and, if thought to be fitting objects of relief, they were given tickets to admit them to the royal presence. When admitted, the patient knelt and was touched by the King. The clerk of the closet now handed his Majesty a gold coin, to which was attached a piece of white ribbon, and, while the King hung this round the neck of the patient, others read the prayers and ceremonies specially appointed for this purpose. We are told that the gold was a token of good-will, and not necessary to the cure, as many were healed without it, or with silver employed instead. Evidences of the efficacy of the royal touch are not wanting: Jeremy Collier says of Edward the Confessor: "That this prince cured king's-evil is beyond dispute, and, since the credit of this miracle is unquestionable, I see no reason why we should not believe the rest." John Browne, surgeon to Charles II, and a man of eminence and reputation in his profession, wrote an "Anatomick-Chirurgical Treatise on Glandules and Strumæ, together with the Royal Gift of Healing or Cure thereof by Contact or Imposition of Hands," etc. In this treatise he gives "many wonderful examples of cures by the sacred touch" of Charles II; he also relates several cases of scrofulous tumor and sore cured by being touched with handkerchiefs which had been dipped in the blood of the martyr Charles I, and asserts that the usurper Cromwell tried in vain to exercise this royal prerogative, "he having no more right to the healing power than he had to regal jurisdiction." Wiseman, in his work on surgery, which was the best book on the subject at that time, says: "I myself have been a frequent eye-witness of many hundred cures performed by his Majesty's touch alone, without any assistance of chirurgery"; still it does not appear that he sent his patients to the King, and he gives his own method of curing scrofula with great minuteness. This evidence as to the cures is apparently most complete, and is that of men skilled in the medical art who were eye-witnesses and assisted in the ceremonies. Of course now no one believes that there was virtue in the royal touch any more than that the philosopher's stone could convert baser metals into gold. If the King could cure scrofula, how is it that during Charles II's reign scrofula was more prevalent than for many years previously? No doubt it was because people neglected ordinary methods of treatment, in their desire to be cured miraculously.

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* The gold coin presented to Dr. Johnson by the Queen is at the present time in the British Museum.

The only way it is possible to explain the evidence of Browne and Wiseman is that they were ardent royalists, and held the efficacy of the royal touch to be as much a party tenet as the divine right of kings, and that by doing so they pleased the court and so advanced their own interests. Had they doubted it, they would have incurred the suspicion of being disaffected to the government.* Failures of cure were attributed, as in our own day, to want of faith, as one writer puts it, "none ever failed of receiving benefit unless their little faith and credulity starved their merits."

Curing diseases by the laying on of hands was practiced with great success by Valentine Greatraikes, an Irish gentleman of good family, who served under Cromwell both in a military and civil capacity. At the Restoration, being deprived of his offices, he undertook to cure the king's-evil by touch, or stroking, as it was called; he succeeded so well in this that he extended the field of his labors and treated epilepsy, asthma, convulsions, deafness, etc., by the same method. The latter diseases being all due to disorders of the nervous system, benefit was no doubt frequently obtained through the effect of the imagination. "Imagination," says Lord Bacon, "is next akin to a miracle-working faith." Greatraikes's fame soon spread, and he was sent for from far and near; the Earl of Orrery and Lord Conway patronized him, and he even deceived the great Robert Boyle. At length he arrived in London, where for some time he was most popular. The majority of his admirers were ladies, and on the more hysterical of the sex he performed marvelous cures. Soon, however, the tongues of slander and ridicule assailed him, and he retired to his native country and obscurity. Many others succeeded Greatraikes. John Everett, or Leverett, the seventh son of a seventh son, and a gardener, practiced the "manual exercise," and declared that after touching thirty to forty a day he felt the goodness go out of him. No doubt these people practiced unconsciously what Mesmer many years after practiced by design. On the subject of Mesmerism and spiritualism I do not propose to enter. Of late years cures by the laying on of hands, assisted, however, by prayer, and the anointing with oil, have become very common, especially in the United States, the hot-bed of all sorts of quackeries. This summer there has been a "faith convention" at Old Orchard, in Maine, where many people were publicly cured by this method; all the diseases treated appeared to be, from the indefinite history of cases reported in religious newspapers, affections of the nervous system. Many hysterical cases were possibly benefited purely by the effect of the imagination : as the disases are ones of the imagination, so are the cures. We have yet to hear of a case of actual disease, such as is daily seen in our hospitals, cured by this method.

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* One Thomas Rosewell was actually tried for high treason in 1684 for saying that "people made a flocking to the King, upon pretense of being healed of the king's-evil, which he could not do, but that they, being priests and prophets, could by their prayers do as much." Rosewell was tried by the celebrated Judge Jeffries and found guilty, but afterward pardoned.—(Wadd's "Mems and Maxims," p. 136.)

The immediate progenitor of our present race of quacks is Paracelsus, who flourished in the sixteenth century; he generally styled himself Philippus Aureolus Theophrastus Paracelsus Bombastus von Hohenheim. His father, who was the natural son of a prince, gave him an excellent education. He studied medicine, and afterward was for some time professor at Basle, in Switzerland. Paracelsus denied the utility of knowing the cause or mode of origin of disease ; he said all he wanted to know was, how to cure it. He styled himself the monarch of physicians, and asserted that the hair on the back of his head knew more than all the writers from Galen to Avicenna, and he publicly burned their books. He invented a nostrum called "azoth," which he vaunted as the philosopher's stone, the tincture of life. He proclaimed that he had the power of making man immortal, yet he died at the age of forty-eight. Still, by the aid of opium, antimony, and mercury, he performed some wonderful cures, and to him must be awarded the credit of first drawing the attention of the profession to the value of these remedies in the treatment of diseases. He also helped medicine to advance by showing contempt for traditional methods of treatment and the humoral pathology of the ancients, which had held sway for over two thousand years.

The most remarkable example of credulity and superstition of the public is found in the history of two quackeries which flourished in the sixteenth and seventeenth centuries. I refer to the *weapon-ointment* and *sympathetic-powder* cures. The weapon-ointment was used in healing wounds ; but, instead of the ointment being applied to the wound, it was applied to the weapon which caused it. This was fortunate for the people so treated, as the applications to fresh wounds in those times were most barbarous. The ointment was prepared in various ways, and its ingredients were most diverse, consisting of human fat and blood, mummy, moss from a dead man's skull, bull's blood and fat, etc. At one time there was a schism in the weapon-salve school, and a serious and acrimonious discussion arose as to "whether it was necessary that the moss should grow absolutely on the skull of a thief who had hung on the gallows, and whether the ointment, while compounding, was to be stirred with a murderer's knife." The mode of application was this: The wound was first washed, bandaged, and ordered to be kept at rest, and then the offending weapon was anointed with the salve, carefully wrapped up, and placed in a safe position. If the weapon was left undisturbed the wound healed in a few days, but, if anything happened to the anointed weapon the wound would break out afresh. In Dryden's version of Shakespeare's "Tempest," he makes Ariel say, in reference to the wound received by Hippolito from Ferdinand:

> "He must be dressed again, as I have done it:
> Anoint the sword which pierced him with this weapon-salve;
> Wrap it close from air, till I have time to visit him again."

In Glapthorne's comedy, "The Hollander," the doctor says, "The same salve will cure at any distance, as if a person hurt should be at York, the weapon dressed at London, on which the blood is." That the belief in this salve was not universal is proved by an attack made on it by John Hales, of Eton, in a letter "to an honorable person" in 1630. He declares it is a child of but yesterday's birth, one among the pleasant fantasies of the Rosicrucians; and, as for the cures it has worked, "the effect is wrought by one thing, and another carries off the glory," etc.*

The *sympathetic powder* was much the same kind of remedy, and was introduced into England by Sir Kenelm Digby, a gentleman of the bedchamber of Charles I. It is said that a Carmelite friar, returning from the East, brought the recipe for this powder with him. Sir Kenelm did him some service, and was rewarded by obtaining the secret of the sympathetic powder. It consisted merely of blue vitriol prepared with mysterious ceremonies. Digby revealed the secret to James I, who disclosed it to Dr. Mayerne, his physician. The latter sold it to many distinguished persons, and then it soon ceased to be a secret. A solution of the powder was made, and some of the wounded man's blood-stained garments immersed in it, the wound at the same time being washed and bandaged, and strict abstinence being enjoined on the patient. As may be inferred, the sympathetic powder, like the weapon-salve, was quite as efficacious at a distance as near by. These remedies did one good: they taught people how soon wounds heal if kept clean and undisturbed, and, in fact, opened the way to our present method of treating wounds. Surgeons learned that, in their healing, Nature was a powerful factor, and must be aided, not interfered with.†

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* Chambers's "Book of Days," vol. ii.

† A somewhat similar superstition exists in many parts of the country to this day. I well remember, when a child, that, having my hands full of warts, they were rubbed by my nurse with a piece of raw meat; the meat was then placed under a stone, and I was told (and this was generally believed) that as the meat decayed the warts would disap-

It would be impossible for me to describe a tenth part of the quacks who flourished in England during the eighteenth century. There was Joanna Stevens, to whom Parliament voted £5,000 in 1739, for disclosing the secret of her remedy for dissolving stone. The wonderful secret remedy consisted chiefly of powdered snail- and egg-shells, and, notwithstanding its disclosure, "there have been as many human calculi since formed by his Majesty's liege lithotomical subjects as would macadamize one side of Lincoln's Inn Fields," says Wadd. David Hartley, the philosopher, was a great supporter of Joanna Stevens, and, after eating two hundred pounds' weight of her remedy, he himself died of the stone. There was Sir William Read, originally a tailor and cobbler, and afterward a quack oculist, knighted by Queen Anne, and who not only had the care of her eyes, but also treated George I. There was the clever but vain Hill, who quacked a gout specific called "tincture of bandana," and of whom Garrick has happily said:

> "For physic and farces his equal there scarce is—
> His farce is a physic, his physic a farce is."

He commenced life as an apothecary, and ended by making a considerable figure in the fashionable world and marrying the sister of Lord Ranelagh.

Three of the most notorious quacks who imposed on the credulity of the public during the middle of the eighteenth century attained sufficient fame to be made the subject of a satirical picture by Hogarth. The picture was called "The Undertaker's Arms," with the motto "*Et plurima mortis imago*," and the most prominent figures in it were—first, Chevalier Taylor, a quack oculist of unparalleled effrontery, who wrote a most marvelous biography of himself, which at one time had a great sale; second, Joshua Ward, originally a footman, who invented a pill and drop; he was called in to see the King, who, in spite of the remedies administered, recovered—Ward for his services received a vote of thanks from the House of Commons, and got leave to drive his carriage through St. James's Park; and, third, last but not least, the celebrated Mrs. Mapp, the Amazonian bone-setter of Epsom, who surpassed all her rivals in quackery, and whose strength of arm was only equaled by her strength of language. She was the daughter of Wallis, a bone-setter, and sister of "Polly Peachem," who married the Duke of Bolton. She drove about London in a coach-and-six with outriders, and the most exalted in rank and station eagerly sought the company of this drunken female savage. She succeeded Taylor and Ward, and is sung of as follows by some Grub Street poet:

> "In physic as well as in fashion we find
> The newest has always the run with mankind;
> Forgot in the bustle 'bout Taylor and Ward,
> Now Mapp's all the cry, and her fame on record.

---

pear. The result of the experiment I can not remember, but I imagine the warts remained for some time after the decay of the meat.

So what signifies learning, or going to school,
When woman can do without reason or rule?"

England in the eighteenth century has been truly named the "Paradise of Quacks." Our ancestors were assuredly a nostrum-loving lot, from the King to the peasant. Truly they must have thought with the prophet, "The Lord hath created medicines out of the earth; and he that is wise will not abhor them" (Ecclesiasticus xxxviii, 4). Perhaps the most remarkable of unblushing quacks who flourished toward the end of the eighteenth century was Dr. Graham, a graduate of Edinburgh, and a fellow-student of Sir James Mackintosh. He introduced Mesmerism into England, and was nearly as successful as his master. In 1780 he went to London and occupied a magnificent mansion, which he designated the "Temple of Health and Hymen." It was gorgeously furnished, and a fortune was spent on the decorations. The spacious rooms were adorned with marble statues, stands of armor, plates of burnished steel, and superbly lighted with wax-candles; sweet strains of distant music were continually floating through the air, and delicious perfumes were always burning in swinging censers; at the door were stationed two gigantic porters, clad in showy liveries covered with gold lace. In this "Enchanting Elysian Palace" Dr. Graham delivered his lectures on health and procreation at two guineas a head, and he did not want for hearers. In his *séances* he was assisted by a beautiful woman, whom he called Vestina, the rosy goddess of health—she who afterward became Lady Hamilton, the favorite of Nelson. In the daytime he was assisted in his electrical experiments by Dr. Mitford, the father of the celebrated authoress. In this temple was a celestial bed standing on glass legs and ornamented with the richest hangings; he pretended that childless married pairs who slept in this bed would be certain to have heirs. The price was £100 a night, and many persons of high rank eagerly accepted the terms. He then advertised an elixir of life, which, it is said, he sold to more than one noble simpleton for £1,000. One mode of treatment he recommended for prolonging life was the frequent use of mud-baths. Soon, from his religious extravagances, Graham became unpopular, and, retiring from public life, he died poor in the neighborhood of Glasgow.

A species of quackery called "Perkinism," which made a stir in the world in the beginning of the present century, I must now shortly describe, for, among the delusions which have succeeded in imposing on men of education and position, it is pre-eminent. It orignated in America, and to Dr. Oliver Wendell Holmes I am indebted for most of my information on the subject. Dr. Elisha Perkins was born in Connecticut, in 1740; he practiced with success for many years, but, being inspired by the recent discoveries of Galvani, he conceived the idea that metallic substances applied in a certain manner might remove disease. In 1796 he gave to the world his metallic "Tractors." These consisted "of two pieces of metal, one iron and one brass, about three inches long, blunt at one end and pointed at the other." They (so he affirmed) "cured rheumatism, local pains, inflammation, and even tumors, by drawing them over the affected parts for a few minutes." Dr. Perkins patented his discovery, and soon found numerous adherents, many of them being men of wealth and position. His son, Benjamin Douglass Perkins, crossed the Atlantic with the tractors, and in 1798 they were employed in the Royal Hospital in Copenhagen. In London their reputation was quickly established, and they soon became the fashion. The Royal Society accepted Perkins's tractors and book, and passed a vote of thanks to him ; by 1804 a "Perkinean Institution" had been founded, which published transactions and held annual dinners. Lord Rivers was the first president, Governor Franklin vice-president, and Lord Henneker, a fellow of the Royal Society, one of the members. All this time Douglass Perkins was coining money by selling tractors at five guineas each, which cost about ninepence. A hospital was built, where the only treatment was "tractoration." Persons in the highest positions willingly gave testimonials, telling of the marvelous cures wrought on themselves and their friends by these wonderful tractors. The bishops and clergymen on both sides of the Atlantic were most eager to thrust forward evidence on this medical topic; whole pages of panegyric were contributed by them. One writes, "I have used the tractors with success in several other cases in my own family, and, although like Naaman, the Syrian, I can not tell why the waters of Jordan should be better than Abana and Pharpar, rivers of Damascus, yet since experience has proved them so no reasoning can change the opinion" ("Currents and Counter-Currents," p. 85).

Many ministers of religion were furnished with tractors gratuitously, and Dr. Holmes remarks that one of the risks of infancy he had to encounter was Perkins's tractors. The medical profession was ever hostile to the new revelation, and their hostility by many was attributed to jealousy and self-interest. The Connecticut Medical Society, in 1797, expelled Dr. Perkins, for violating their regulations against nostrums and secret remedies. The bubble was burst by Dr. Haygarth, of Bath, who experimented on patients with bogus tractors made of wood : he was quite as successful with them as with the five-guinea ones ! These experiments did not immediately destroy the belief of the real Perkinistic enthusiasts, because, as Froude says, "belief in the marvelous does not rise from evidence, and will not yield to it." After a time, however, Perkinism passed away so quietly that the date of its death is unrecorded. Lord Byron, in his "English Bards and Scotch Reviewers," refers to these celebrated Tractors :*

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* "Thus saith the Preacher, 'Naught beneath the sun
Is new,' yet still from change to change we run ;
What varied wonders tempt us as they pass !—
The cow-pox, *Tractors*, galvanism, gas,
In turns appear to make the vulgar stare,
Till the swoll'n bubble bursts—and all is air !"

Within the last few years, a form of Perkinism, or rather "metallic medicine," has appeared in Paris, clothed in the garb of science, and under the protecting influence of the great M. Charcot. Gold, silver, and other metals, in the form of coins, are applied to relieve the manifestations of the graver forms of hysteria. It has become quite the 'mode' to visit the Hôpital de la Salpêtrière, and witness the sensational cures performed publicly on the victims of hystero-epilepsy. This notoriety is both pleasing to the patients and the public. If a nervous disease is treated by unusual methods, it becomes common; hysterical subjects having always a morbid desire to make themselves remarkable, and so be the center of attraction, it pleases their vanity and self-love. The consequence of the introduction of metallo-therapy into Parisian hospitals as a mode of treatment is, that in Paris and its neighborhood an enormous number of these rarer forms of hysteria and hystero-epilepsy have been, so to speak, created, and the wards of some of the hospitals there are crowded with female patients, eager to be treated in a sensational and novel manner. They certainly derive benefit from the treatment, because, as a writer in the "Lancet" has said: "The symptoms for which metals are applied can not be ascertained without calling the patient's attention to their existence; the strange and unusual remedy of application of a string of coins can not be adopted without exciting expectation of a local result—an expectation which it has been often demonstrated is sufficient to determine the disappearance of local symptoms in this remarkable disease."

My paper would be very incomplete should I fail to mention the most successful quack this century has produced, John St. John Long. He was the son of an Irish basket-maker, and was born near Doneraile. In his boyhood he assisted his father, but, soon tiring of rush-weaving, being a clever, pushing youth, he attached himself to a Dublin portrait-painter, from whom he obtained some knowledge of painting. When next we hear of him he is starring the provinces as an historical and portrait painter, and an instructor in the art of painting in oils. It was at this time that he adopted the name St. John. With the Limerick gentry he was a great favorite, because of his entertaining manners, and his ability to ride straight across country. Becoming disgusted with provincial life, and feeling that his talents could be more profitably employed in a larger sphere, he went to London. Here, by his pleasant address and persuasive tongue, he managed to get introductions into several respectable houses, and was elected a member of the Royal Society of Literature and of the Royal Asiatic Society. But he could not live on these honors, and was glad to color anatomical drawings for the lecturers and students at the various schools of anatomy. In this way he learned something about the human frame, and before many months had passed he proclaimed to the world the discovery of a wonderful liniment, which, when applied to a healthy part, was as harmless as water, but when applied to a surface covering a diseased organ caused the morbific humor to exude. His success was immediate and great. Patients from London and all parts of the country rushed to consult the miracle-worker in his house in Harley Street. Ladies of the highest rank hastened to place themselves and their ailing daughters under his care. Long was shrewd enough not to undertake the cure of cases which were apparently hopeless. He pretended to cure consumption by the application of his liniment, and of course, as nine out of ten of his patients were women, and a large majority of these hysterical or perfectly healthy, his success was marvelous. For several years his income exceeded £13,000. He went out into fashionable society, and was a lion in the most aristocratic circles; his ready wit, fascinating manners, intellectual countenance, and handsome figure, procured him a host of admirers, among whom were Lord Ingestre, the Marquis of Sligo, Lady Harriet Kavanah, the Marchioness of Ormond, the Countess of Buckinghamshire, and many others. Long was a superb horseman, hunted regularly, and rode magnificent animals. "On one occasion, as he was cantering round the park, he saw a man strike a woman, and, without an instant's hesitation, he pulled up, leaped from his horse, seized the fellow bodily, and flung him over the park-rails." He had many offers of marriage, but declined them all. He wrote a book called "Discoveries in the Science and Art of Healing," which was well padded with letters from grateful patients, and testimonials of miraculous cures from his aristocratic friends. Soon misfortune came upon him; his liniment was applied to the back and breast of a perfectly healthy girl, inflammation set in, followed by gangrene, and in a few days his patient was no more. Long was convicted of manslaughter, and fined only £200 by a partial judge. In his trial he was supported and petted by his lady admirers, who gave evidence in his favor. One nobleman swore that Long had abstracted pure quicksilver from his head. Soon another patient fell a victim to his treatment; he was again tried for manslaughter, and again had the sympathy of his female friends, but this time he was acquitted. These trials had no effect in lessening his popularity: he went about proclaiming himself a martyr, comparing his case to that of Galileo, Harvey, and others. He died while still young, in 1834, retaining a large practice to the last. His admirers raised a magnificent monument to his memory in Kensal Green Cemetery, adorned with a long and laudatory inscription. After his death, his property became the subject of very tedious litigation. Among the claimants was a woman of humble station in life, who proved to be his wife. This explained his preference for bachelorhood. The wonderful liniment turned out to be *acetic acid*, which looks much like water. He of course substituted a bottle of water when he did not wish the "morbific humor" to come out, and so gulled his willing victims.

George Eliot, in "Middlemarch," alludes to St. John Long and his quackeries.

Homœopathy is another form of quackery to which I must shortly allude. It originated in 1796, with Hahnemann, a German physician. Hahnemann laid down, as necessary to his system, three great foundation truths:

1. *Similia similibus curantur.* This means that diseases are to be cured by the administration of substances which, in healthy individuals, produce the same symptoms or group of symptoms as the disease itself manifests. This idea was not original with Hahnemann. Hippocrates distinctly enunciates it, and since then it has been held by many physicians and others, including Paracelsus, who was the inspirer of Hahnemann.

2. That it is necessary to give remedies in infinitesimal doses. Substances which are given by the regular school in doses of four to five grains, homœopaths should give in quantities of two decillionths of a grain and less. Hahnemann says, in his "Organon": "But, if the patient is very sensitive, it will be sufficient to let him smell once of a vial containing a globule of sugar the size of a mustard-seed; after the patient has smelled it, the vial is to be recorked, and will thus serve for years without its medical virtues being perceptibly impaired." This second "great truth" was, as has been lately pointed out by Dr. Holmes, adopted from Van Helmont, a physician who flourished in the early part of the seventeenth century. He denied the existence of the four elements, and held up to ridicule the practice of letting blood for the cure of disease.

Van Helmont, in his "Ortus Medicinæ," describes a method of treatment made use of by one Butler, an Irishman, who was formerly physician to James I, and at that time was confined in prison in Belgium. According to Van Helmont, Butler performed wonderful cures with a pebble he had in his possession. He dipped this pebble quickly into a teaspoonful of olive-oil, poured this "magnetized oil" into a large vessel of oil, and directed the patient to take one drop occasionally. When one drop was put on the head of an old woman suffering from hemicrania, the pain instantly disappeared. An abbess was relieved of loss of power in her right arm by merely touching her tongue to the pebble. No doubt reading this book first suggested infinitesimal doses to Hahnemann.

Hahnemann's "third dogma or truth" was, that seven eighths of all chronic diseases are produced by psora, or itch. "This psora," says Hahnemann, "is the sole, true, and fundamental cause that produces all the other countless forms of disease, which go under the names of hysteria, hypochondriasis, debility, insanity, melancholy, idiocy, epilepsy, cancer, gout, paralysis," etc., etc. (I shall not complete the list). He tells the reader in a foot-note that it took him twelve years to trace out the source of all these diseases. This third dogma was original with Hahnemann, and no one now wishes to detract from the laurels he may have won by thus simplifying the etiology of diseases which hitherto have been so obscure in their origin.

Unfortunately for his theory, since the discovery of the *sarcoptis hominis*, or itch-insect, the dogma about the psora being such a powerful factor in the causation of disease has fallen to the ground, and homœopaths are not fond of referring to it. Like Paracelsus, Hahnemann paid no attention to the pathology * or cause of disease, but only sought for symptoms. For instance, in a case of dropsy, the cause, whether it be from the heart, the kidneys, or the liver, is not inquired into, but the symptom dropsy is treated. Dr. Black, in his "Practice of Homœopathy," tells us: "If the cause of the disease be an inflammation of the brain, a remedy has to be chosen which produces this pathological condition; and, if the exciting cause can be traced to the abuse of alcoholic liquors, a remedy should be selected which is nearest akin to alcohol in its action." This is what is called "a proving."

The dilutions are directed to be prepared by Hahnemann with as much mystery and jugglery as the "sympathetic powder." The following directions are taken from Hahnemann's "Organon": "A grain of the substance, if it is solid, and a drop, if liquid, is to be added to about a third part of 100 grains of sugar of milk in an unglazed porcelain capsule, which has had the polish removed from the lower part of its cavity by rubbing with wet sand; they are to be mingled for an instant with a bone or horn spatula, and then rubbed together for six minutes; then the mass is to be scraped together from the mortar and pestle, which is to take four minutes, then to be again rubbed for six minutes with equal force. Four minutes are then to be devoted to scraping the powder into a heap, and the second third of the 100 grains of sugar of milk to be added. Then they are to be stirred an instant and rubbed six minutes, again to be scraped together for four, and forcibly rubbed for six, once more scraped together for four minutes and rubbed down for six. Then the last third of the 100 grains of sugar of milk is to be added and mingled by stirring with a spatula. Six minutes of forcible rubbing, four of scraping together, six more of rubbing, finish the process. Now to one grain of the powder so manufactured is to be added a third part of 100 grains of sugar of milk, and the whole mixed in a mortar, and having triturated each third portion for six minutes, and scraped for four minutes, the whole powder is placed in a corked bottle and marked with its degree of attenuation, which will be the $\frac{1}{10000}$ or second dilution. The same method is observed for this powder as was detailed for the last for making any attenuation up to a decillionth and quintillionth."

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* A new school, which has arisen within the last few years, also pays no attention to pathology. The members of this school do not wait for symptoms even, but endeavor to "jugulate" the disease at once. They call themselves the "Dosimetric School," because they treat disease by granules containing alkaloids and metallic salts in fixed doses.

The method for making fluid dilutions is the same, but instead of sugar of milk alcohol is used. The scrapings and triturations are exchanged for shakes of the bottle in certain directions. Toward the close of his life Hahnemann reduced the number of his shakes. He says, "A long experience and multiplied observations upon the sick lead me within the last few years to prefer giving only two shakes to medicinal liquids, whereas I formerly used to give ten."

Now to give one an idea of the potency of these drugs: to obtain a grain of the original substance in the third attenuation, one would have to swallow four hundred-weight of sugar; or, to get a drop of the original tincture, a barrel of alcohol would have to be imbibed. Now, this is only the third dilution. In the eighth dilution, to obtain a drop of the tincture the whole Atlantic Ocean full of alcohol would be necessary. Dr. Black, to whom I have referred, says he uses the first, third, sixth, ninth, up to the thirtieth dilution. Imagine the effect of one-drop doses of the thirtieth dilution! The finite mind can not comprehend the infinitesimal when thus expressed.

Homœopathy, although not yet deceased, retains hardly anything of its original character but the name. The efficacy of infinitesimal doses is doubted by the leaders of the school, and even the doctrine of *similia similibus curantur* is not now considered universal. Dr. George Wild, Vice-President of the British Homœopathic Society, in a letter to the London "Lancet," June, 1877, says that he believes "palpable doses of medicine are generally more efficacious in the treatment of disease than infinitesimal ones." Also, that "some diseases are best treated by similars and some by contraries."

The third dogma, with regard to the psora, or itch, has been, since the discovery of the itch-insect, effectually disposed of forever. As Dr. Holmes remarks, "What there is left of the three-legged stool after one of its legs is pulled out, and the other two sawed half or three quarters through, seems hardly worth sitting down on."

The name homœopathy has a charm for the public, and so is retained to juggle with. When, in 1833, the edition of the "Organon" from which I have quoted was published, the translator, in the preface, mentioned that this new system of medicine was spreading through the Continent of Europe with the rapidity of lightning. In 1880, in an address read before the Institute of Homœopathy, in Milwaukee—"How can we best advance Homœopathy?"—the author says: "It can not be denied that homœopathy has not advanced, and is not advancing, as rapidly as we once had just and reasonable grounds for expecting. In Great Britain there are but two hundred and seventy-five homœopathic physicians, and in the United States there is not one legally recognized school of homœopathy." He concludes by saying that there seems to be everywhere stagnation, if not retrogression. Dr. Smyth, in his book on "Medical Heresies," mentions that a short time since the County Hospital, Sacramento, was in charge of homœopathic physicians; quite recently they have been relieved from further attendance by the managers, because of the extravagant expenditure of money for drugs. Among the items are three pounds of salicylic acid and four thousand grains of quinine.

In Ontario, up to ten years ago, homœopaths were yearly registered by scores; since then they have to pass through the same courses and examinations as the regular students, in all but therapeutics and pharmacy. The consequence is, that in ten years there have only been two or three applications for examinations as homœopaths. Homœopathy, being a system utterly devoid of any scientific foundation, is now dying a natural death.

It is difficult to give the exact reason or reasons why quackery is so prevalent. The causes are very various and obscure. Southey says: "Man is a dupable animal; quacks in medicine, quacks in religion, and quacks in politics know this, and act upon that knowledge. There is scarcely any one who may not, like a trout, be taken by tickling." It is extraordinary what a hold the mystic and marvelous still have on many people; there seems to be in almost every one a vein of credulity and superstition against which argument is useless. The disposition to be humbugged preponderates in human nature over reason and common sense. Education, at least the education of the day, apparently has no influence in depriving people of this quality. Men of education are the very ones who have been, and are now, duped by clever quacks. A man may be an able politician, distinguished in literature, of great shrewdness in the ordinary business of life, and yet believe in spiritualism, homœopathy, Perkinism, and tar-water. When he is ill he will probably, after taking in vain the various much vaunted and advertised panaceas, call in some quack who promises a cure in a certain time and in some uncommon manner.

Bishop Berkeley is an example of a man of great attainments, whose mind was obscured by quackery. His tar-water he considered an infallible remedy for all ailments, and wrote a book describing its universal efficacy in curing disease. Dr. O. W. Holmes says: "He might have lived longer, but his fatal illness was so sudden that there was no time to stir up a quart of the panacea. He was a very illustrious man, but he held two very odd opinions, that tar-water was everything, and that the whole material universe was nothing ("Currents and Counter-Currents," p. 72). Alfred Russel Wallace,* the eminent naturalist and evolutionist, Mr. Crooke, the celebrated physicist, and Pasteur, the scientist, are ardent spiritualists, and believe that diseases may be cured by means of spiritualism. Disraeli was a homœopathist; Sir Robert Walpole patronized a quack medicine, said to dissolve the stone; Lord Bolingbroke died from the effects of a quack cancer-remedy; and I could enumerate many more men of equal talents who were similiarly affected with this mental obliquity.

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* Mr. Wallace, in his book on "Miracles and Modern Spiritualism," holds that the theory of a future existence as taught by spiritualists is the "only one yet given to the world that can at all commend itself to the modern philosophical mind," and in the spiritual world the law of "progression of the fittest" takes the place of the grand law of the "survival of the fittest" in the material world. He also holds that witches were what are now called "mediums." Owing to the number of witches destroyed for several centuries, the production of spiritual phenomena became impossible, which accounts for spiritualism being of comparatively recent origin.

Probably the greatest supporters of quacks and quackeries, next to the fair sex, are ministers of religion; hardly an advertisement of a quack-remedy can be read without coming across testimonials from them. They are generally the first to support any new form of charlatanism. In the country parts, especially, while administering to diseased souls they love to essay the efficacies of new cure-alls on diseased bodies. This weakness may be attributed to their well-known benevolence, and desire to do good to their fellow-men.

If anybody is bold and unblushing enough to assert that he has a remedy which cures every disease, and reiterates it often and loudly enough, he is sure to have a following of believers, among whom will be found men of ability and position. Human credulity is too strong to resist the frequent and positive assertions of the quack. Persons who are not trained in scientific methods of thought, and who know nothing about physiology, even if in the every-day affairs of life they are most clear-headed, are perfectly incompetent to form just opinions on medical matters.

The arguments in favor of the different forms of quackery are always the same. They say, "I was ill, I took a certain remedy or went through a certain form of treatment, and got well." This argument is irresistible, and "therefore quackery is immortal." Now, nine out of ten, nay, I venture to say nineteen out of twenty people, suffering from the ordinary acute diseases, if left to nature, get well. In every case of illness a quack administers remedies, and, of course, if the patient recovers, his recovery is attributed to the remedy; consequently the proportion of cures is large, and the number grows in the telling. In olden times, when diseases were treated by charms, fastings, prayers, and ceremonies, many of the physicians and priests, not understanding the power of nature, thought themselves favored with supernatural assistance. The quack of to-day, however, thoroughly understands what an able partner Dr. Nature is. If you ask a believer in some form of quackery the *modus operandi* of the drug or application, he tells you that there are many mysteries in nature which it is impossible to understand. If you attribute the effect to imagination, he answers that the remedy is quite as efficacious administered to young children and brute beasts, but, as Dr. Haygarth observes, "In these cases it is not the patient, but the observer, who is deceived by his own imagination."

Now, when any remedy has to be tested as being useful in a certain disease, we have, first, to be sure that the disease exists; secondly, that it was cured; and, thirdly, that the remedy cured the disease.

It is very common for quacks to call carbuncles cancers, ordinary sore-throats diphtheria, and so on, and so boast of their wonderful cures, when Nature alone deserves the praise. In no country in the world are quacks more abundant than in the United States. Every city teems with faith-cure men, rubbers and strokers, clairvoyants, homœopaths, eclectics, bone-setters, cancer-doctors, etc., etc. The advertising columns of the daily and weekly press, in the smaller towns especially, are principally filled with quack advertisements, some of them of the most disgusting and disgraceful nature, and these too in perfectly respectable sheets, which find their way without question into family circles. Religious newspapers are no exceptions to the rule; in them the advertisements have a religious gloss to attract the holy. Perhaps texts are quoted, or the advertiser poses as a philanthropist or clergyman, and treats the poor *gratis*; at the same time he hints that the only reason he is so generous is that he *enjoys* the luxury of doing good to suffering humanity. Quacks have many ways of advertising. One asserts, as a scientific fact, that all diseases originate in disorders of the nervous system, and urges every one, before it is too late, to come and drink of his nervine tonic. Another states that physicians now admit that all diseases are due to impure blood, and vaunts the efficacy of his magnetic blood-purifier. Then comes a vile woodcut of the inventor, with a list of the testimonials of the most laudatory character, showing how this more than human doctor had snatched the writer from the jaws of death, and perhaps something worse; or perhaps we have a "Golden Medical Discovery," and are told that the receipt for this medicine was found in the luggage of a deceased Zulu chief, or that it had been a secret of the medicine-men among the Yucatan Indians for hundreds of years, and was providentially discovered by the advertiser. To suit patients who dislike internal remedies, artful and designing quacks have furnished liver, stomach, and kidney pads, and magnetic belts, giving illustrations at the same time to show how these should be applied. I have been told by a wholesale druggist that thousands are sold by the trade, monthly, to the credulous who are continually seeking for new medical divinities. Their action is much the same as Perkins's Tractors. That these advertisers are successful in selling their wares is shown by the enormous prices they pay for advertising, and the colossal fortunes which men like Holloway, Helmbold, Ayer, and others have made. If bread-pills were to be advertised, until they came into notice, as some wonderful vegetable compound from the center of the "Dark Continent," and that they cured all diseases, they could not fail to acquire celebrity, for, of the thousands who would take them, a certain number would be sure to get well.

Another kind of quack is one who does not charge for advice, but when a patient consults him he terrifies him into believing he has some serious disease which only his medicine can cure. This is a very old form of quackery. Robert Pitt, in a book called "The Crafts and Frauds of Physic exposed," published in London in 1703, says, "A quack is a practitioner who takes no fee in specie, but makes the deluded patient pay very extravagant fees by the intolerable prices he puts on all cheap medicines, and by passing upon him very many more doses than the disease requires or the constitution can bear."

That this, the last quarter of our nineteenth century of progress and boasted enlightenment, is as rich in credulity and superstition as any of the preceding ones, is proved by the fact that thousands yearly visit shrines and sacred springs, if Catholics, and attend "faith conventions," if Protestants, to be cured of bodily ailments. Not long since one of England's proudest nobles traveled on a pilgrimage to Lourdes in the hopes that Notre Dame de Lourdes would make his only son, who is a deaf-mute, hear and speak. Every day in our own immediate neighborhood, hundreds and thousands of the maimed and the blind make pilgrimages to the sacred spring of Ste. Anne de Beaupré and are miraculously healed—have they not a mountain of crutches bearing witness to the fact? Lately in this city (Montreal), a noted female quack has made the blind to see and the lame to walk—at least I have been told so by eye-witnesses—and in consequence has attracted crowds of infatuated simpletons, who could not hand in their dollars fast enough to secure a bottle of her wonderful nostrum. The priests of a neighboring city, jealous of poaching on their own grounds, denounced her as a charlatan, and told the afflicted that, instead of being duped by this unholy woman, they should make a pilgrimage to Ste. Anne de Beaupré and be healed!

The success of this mode of treatment in hysterical cases is being recognized in France by physicians: they now, when they have an hysterical patient of a devout frame of mind, on whom they have exercised their skill in vain, as a *dernier ressort* advise that a visit should be made to the shrine of Notre Dame de Lourdes. Thus imagination often works a cure where medicine fails. These cures, as I said above, only take place when the disease is one of the imagination.

Why is quackery so much more prevalent in medicine than in any other science? Because the medical quack attributes to himself what is due to Nature. Nature can not build a railway, but she can very often cure disease. A witty Frenchman has said that medicine amuses the patient while Nature cures the disease.

Is there ever any chance of quackery becoming extinct? I fear not as long as human nature exists in its present condition. Still, no doubt, there is a probability of the number of believers in quackery being diminished by a greater diffusion of philosophical habits of thought and a more general knowledge of physiology. A writer many years ago, in one of the London medical papers, said: "The final though distant extinction of quackery is to be hoped for; it forms a fragment of that final triumph of reason and virtue which is the secret consolation of every philanthropist."

RECENT MAGNETIC STORMS AND SUN-SPOTS.

By GARRETT P. SERVISS.

NO one who beheld the great auroral displays of last year can ever forget the impression that they made. They were among the most glorious celestial spectacles that have been witnessed in our latitudes. The first one occurred on the night of Sunday, April 16th. On the afternoon of that day I was watching with a telescope two complicated sun-spots, or groups of spots, one of enormous size, which had made their appearance on the solar disk several days before. My attention had been particularly attracted to these spots, both on account of their great size and because I thought I could perceive changes going on in them under my eyes. After watching them through the afternoon I became satisfied, about an hour before sundown, that the smaller spot, which was considerably in advance of the other, and was rapidly approaching the sun's meridian, had visibly increased in size while I had been watching it, and that perceptible changes had taken place in the complicated cluster of nuclei constituting the black center of the greater spot. It was evident that a tremendous outburst of solar forces was occurring; but, although I knew of the well-established connection between such convulsions in the sun and the condition of the earth's magnetic elements, I was not prepared for the spectacle that followed.

The sun had been below the horizon only long enough for the lengthening spring twilight to fade from view, when a pale-green arch of light was seen spanning a broad arc of the northern horizon, while above it the mysterious streamers and curtains of the aurora were waving and coruscating in the sky. So quickly had the earth responded to the magnetic impulse from the storm on the sun. The popular excitement caused by this aurora was remarkable, especially among those who were not aware of the nature of the strange illumination in the sky. People gathered in knots at the street-corners, and in the little parks of the city, and gazed wonderingly at the flaming heavens. Many seemed to be seized with a mingled feeling of admiration and dread. I crossed the Fulton Ferry after midnight, when the auroral streamers were yet shooting from horizon to zenith, and Arcturus was shining brilliantly in the center of a complete crown of greenish-yellow light near the zenith. A throng gathered at the bow of the boat to watch the display, which was much more brilliant when seen from the center of the stream, away from the glare of the street-lamps. A decently-dressed and not unintelligent-looking man asked me, with a troubled look, and pointing to the heavens:

"What *is* that?"

"It's the aurora borealis," I replied.

He seemed relieved to find some one who could give it a name, and who did not appear to be alarmed.

"I thought it might be the comet the papers are talking about," he said, "and I didn't know what was going to happen."

I know that this man's vague fears were shared by others.

Everybody who had anything to do with telegraphs will remember the effects of the aurora. The wires played strange freaks. In some places they were disconnected from the batteries and worked by means of the current furnished by the magnetic storm; in other places they refused to work at all. The Atlantic cable was crippled, and at intervals, for several days thereafter, there was considerable delay of all telegraphic business. Subsequently it was learned that the auroral storm had raged, simultaneously, not only in the United States and Canada, but in Great Britain, on the Continent of Europe, and in Asia, extending clear across to the shores of China.

The next day, when I turned my telescope upon the sun, I was astonished at the changes that had taken place. The smaller spot, which I had seen increasing in magnitude on the previous day, had swollen to between five and six times its former size, so that now it was about half as large as the larger spot, and both were clearly visible to the unassisted eye, shaded with a dark glass.

I find by reference to the exact measurements of these spots, made at the Greenwich Observatory, that, whereas on the 16th the area of the smaller spot was to that of the larger about as 1 to 13·6, on the 17th the relative magnitudes were about as 1 to 2·2.

For three or four days afterward there were magnetic disturbances and occasional auroral displays at night, and during this time the activity of the solar forces continued.

On the 19th there was another magnetic storm, and coincidently with it the smaller spot suddenly increased in size again, until it was nearly as large as the other, and on the 21st it actually surpassed its neighbor in magnitude. After that both groups rapidly waned, the one which had undergone the remarkable development I have described fading much faster than the other one.

The next great display of sun-spots accompanied by auroras and magnetic disturbances—if we except one or two of minor importance and a somewhat remarkable one seen in Europe, which will be described hereafter—occurred in November last, culminating on the 17th of that month in one of the greatest magnetic storms on record, which crippled the telegraphs almost all over the civilized world. In Europe fine auroras were observed on the 12th, 13th, 14th, 15th, 16th, 17th, and 19th, accompanied by more or less magnetic disturbance. During that time a tremendous sun-spot, exceeding in size the largest of the April spots, was advancing from the edge of the disk to the center. In this country the principal auroral displays were on the nights of the 17th and 19th, and the chief force of the magnetic storm was felt on the 17th. On that day a storm of rain and snow prevailed over most of the Union, and simultaneously with this storm there raged a hurricane of magnetic forces. The effects were similar to those witnessed during the April storm, but more intense. As in April, some wires were worked without batteries, while others could not be worked at all. Cable communication was interrupted. Some startling phenomena occurred. Sparks of fire leaped from the wires and instruments. In the West, switch-boards were burned and keys melted. Operators received severe shocks. Practical telegraph men said they had never known such a powerful disturbance of the magnetic elements. In the evening, when the sky cleared at Chicago, a most magnificent sight was beheld in the heavens. The brilliancy of the aurora far exceeded that of the April display. A singular feature of this aurora, which was also noticed in Europe, was a splendid luminous arch spanning the sky from east to west and passing nearly through the zenith. Another feature that added brilliancy to the spectacle was the variety of color visible. The prevailing tints were rose-color and green, but in some places streamers and patches of violet, yellow, and orange light were seen. On the night of the 19th and morning of the 20th, the sky having cleared here, a splendid aurora was seen in New York. The magnetic disturbance also continued.

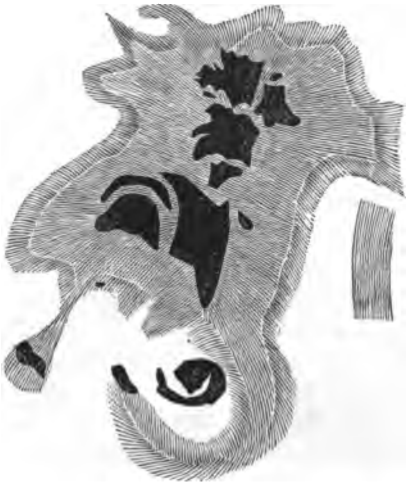

FIG. 1.

At the April meeting of the American Astronomical Society I exhibited some magic-lantern views representing the principal changes which took place in the great sun-spot during the magnetic storm of November. These views, copied from drawings of the spot made at the telescope, are reproduced in the accompanying cuts.

Fig. 1 represents the spot as it appeared on the 16th of November, the day before the culminating magnetic disturbance took place. Low magnifying powers, varying from sixty-five to a hundred and ten diameters, were used while making the drawings, as it was not desired to obtain pictures representing all the details. Consequently, only the principal features of the spot are here represented, but the reader will be able to get a better general idea of the changes that occurred from such a picture than he could from one filled with minor details. The central and lower portions of the figure are especially worthy of attention because of the indications they give of an eddying motion corresponding with what should always be seen in a sun-spot according to Faye's cyclonic theory, but which, in fact, is rarely visible. It was also in these parts of the spot that the principal changes occurred, as will be seen by reference to the figures. It is very interesting to note that in Carrington's drawings of the remarkable sun-spot which accompanied the great magnetic storm of September, 1859—a disturbance whose effects strikingly resembled those produced by the storm of last November—similar indications of a whirling motion can be detected. Another exceedingly interesting fact is that in England, on the 16th of November last, luminous points were seen rapidly crossing the great spot. This forcibly recalls the similar phenomenon of flying points of light, seen by Carrington and Hodgson, darting across the spot of 1859, and which seemed to be a signal for the outbreak of the magnetic storm that followed.

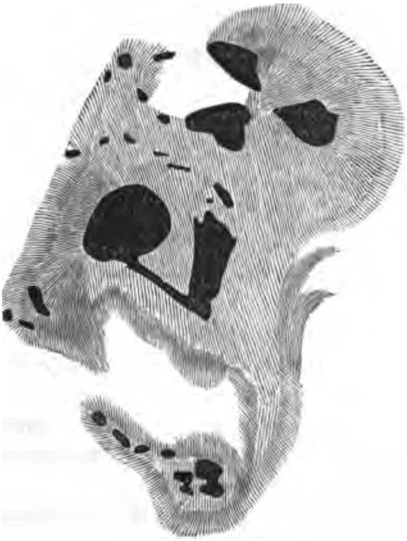

Fig. 2.

In Fig. 2, which represents the spot as it appeared on the 18th, the day after the great magnetic storm, evidences of cyclonic motion are still, perhaps, visible, though they are rather suggested by a comparison of the appearance of the spot with that shown in the previous figure than by any clear indications in the figure itself unconnected with the other one. The roundish, nuclear mass near the center suggests by its form a whirlpool-like motion, but it is difficult on that hypothesis to account for the long, straight channel connecting it with the oblong figure on the right. The peculiar crooked figure seen in the lower part of the first picture has, it will be perceived, apparently broken up into several fragments, but this by itself is not inconsistent with the theory of an eddying motion.

Fig. 3 represents the appearance of the spot on November 19th, auroras and magnetic disturbances having in the mean time continued. Still further changes, it will be seen, have taken place, and the lower portion of the spot shows a tendency to separate from the larger mass above—a phenomenon that is of not unfrequent occurrence.

I find, by reference to my note-book, that other changes were visible on the 20th, but unfortunately I was prevented from sketching them. After that, unfavorable weather, and other interruptions, prevented me from sketching the spot, but the sketches that were made cover the period during which the most remarkable changes occurred, as well as that of the greatest magnetic disturbances. In order to obtain a clear notion of the tremendous forces involved in the changes represented in the drawings, it is necessary to consider the enormous size of the spot as measured in square miles. Counting the whole area covered by the various nuclei and the penumbral depression surrounding them, the spot was not less than 60,000 miles long and 40,000 miles wide. In other words, it covered 2,400,000,000 square miles of the solar surface. The area of the whole surface of the earth, land and sea, is less than 200,000,000 square miles, so that if the crust of the earth had been peeled off like the skin of an orange, spread out flat and plastered against the sun, it would have looked like a mere outlying patch beside the great congeries of sun-chasms constituting this gigantic spot. Masses of gaseous matter, many times greater than the earth in volume, must have been hurled and whirled about there with tremendous velocity in order to produce the changes which the telescope revealed. Milton's description of the battling elements of chaos, through which Satan fought his way, will apply, though inadequately, to the scenes of chaotic fury of which such a sun-spot is the theatre.

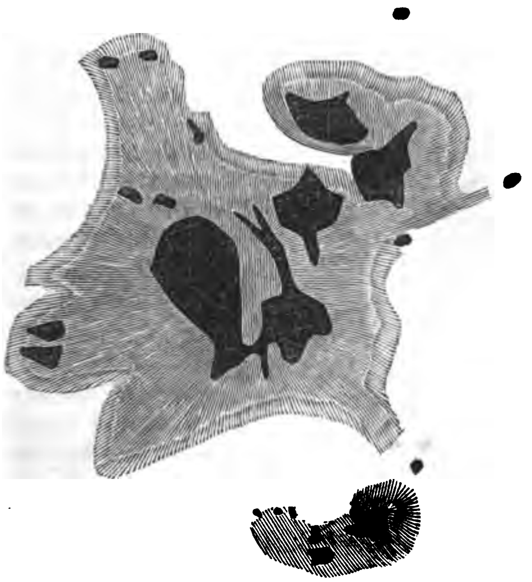

FIG. 3.

In Fig. 4 is represented a very remarkable spot which, because it made its appearance at about the time the great comet was in perihelion, in September last, and broke out on the portion of the solar globe which was nearest to the comet at that time, has been fancifully called the "black eye that the comet gave the sun." There were other spots visible at the same time and they also were ascribed by some to the influence of the comet. Some plausible reasons have been shown in favor of this view, and Professor Kirkwood's opinion that the great sun-spots of June, 1843, were caused by the large comet of that year has been freely quoted in support of it. Of course, the question whether this particular spot and its companions originated in some disturbance caused by the comet, whether by the fall of meteoric masses following in the comet's track or otherwise, can not be settled either way by positive evidence at present. But, while there are improbabilities in the way of the hypothesis, it may, at least, be said that, if any comet could produce a sun-spot without actually tumbling into the sun itself, the comet of last year ought to have been able to do it, for, as is known, it almost brushed the sun in its perihelion swing.

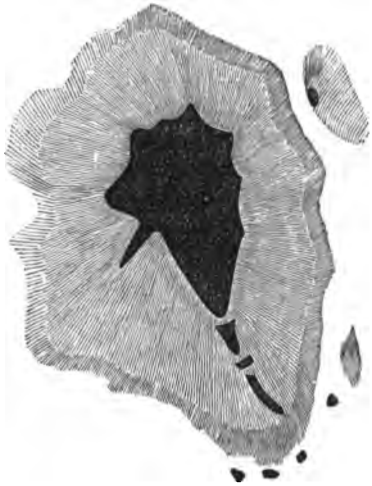

Fig. 4.

This great spot, however, is interesting on another account. The cut represents its appearance on October 1st, when it had reached about its greatest development. On October 2d there was a magnetic storm which was felt principally in Europe. The storm was very much less severe in its effects upon the telegraphs than those of April and November, but it was accompanied by the appearance throughout England, Scotland, and Western Europe of a most beautiful aurora.

In conclusion, it may be said that, while the evidence furnished by the great magnetic storms of last year was hardly needed to complete the chain of proof of the intimate connection between solar outbursts and the magnetic conditions prevailing upon our globe, yet this evidence was of such a striking character that it must rank among the most interesting of all that bears upon this question. It is, perhaps, worthy of remark that the period of sun-spot maximum through which we have just been passing has also furnished a good deal of evidence in favor of the views of those who think a connection can be traced between sun-spots and the weather. It is only necessary to point to the facts that 1881 and 1882, as well as the beginning of 1883, have been remarkable for cyclones, tornadoes, storms, and floods, and that, coincidently with these meteorological disturbances, huge spots and other evidences of commotion have appeared in the sun. Here is a splendid field for investigation.

VIVISECTION IN THE STATE OF NEW YORK.

By BURT G. WILDER, M. D.

"I know that physiology can not possibly progress except by means of experiments on living animals, and I feel the deepest conviction that he who retards the progress of physiology commits a crime against mankind."—CHARLES DARWIN.*

THE objects of this article are—1. To enlarge the slender store of published facts respecting vivisection in the United States. 2. To discuss briefly certain general aspects of the question. 3. To examine the existing and proposed laws concerning it. 4. To consider Mr. Henry Bergh's fitness to initiate such legislation. 5. To express what seems to be the sentiment of most well-informed, humane persons regarding experimentation upon animals.

I. Aside from editorial articles and resolutions of medical societies, public discussion of vivisection in this, the State in which it is already somewhat limited by law, has been nearly confined to four gentlemen besides the present writer. Mr. Bergh's single contribution will be more conveniently considered later. Professor J. C. Dalton has contented himself hitherto with the general statement † that "the exhibition of pain in an experimental laboratory is an exceptional occurrence. As a rule, all the cutting operations are performed under the influence of ether. . . . This is because the infliction of pain is generally no part of the experimenter's object, and on every account it is preferable for him to avoid it." The foregoing refers directly only to laboratory investigations, and it may undoubtedly be inferred that, among the experiments before classes in the lecture-room, the painful constitute a still smaller minority.‡ What they have been is shown by Dr. A. J. Leffingwell # in quotations from the larger physiological treatises of Professors Dalton and Flint. Among the numerous illustrative operations mentioned as performed by these teachers in two of the largest medical schools in the coun-

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* From a letter to Professor Holmgren, April, 1, 1881, published in "Nature," April 21, 1881, p. 583.

† "Experimentation upon Animals," etc., New York, 1875, p. 8.

‡ In a letter to the writer, dated January 11, 1883, Professor Austin Flint, Jr., says, "In my class demonstrations, I do not make experiments upon animals involving more pain than is caused, for example, by pithing to kill, or injecting an anæsthetic subcutaneously."

"Does Vivisection pay?" "Scribner's Monthly," July, 1880, pp. 391–399.

try, there appear to be seven in which anæsthetics are not always employed; in them, there is reason to believe that the pain inflicted is either brief or not very severe. There is also reason for believing that there is an annual decrease in the number of such demonstrations.

Mr. Bergh wishes to suppress vivisection by act of Legislature. Dr. Leffingwell would legally restrict painful experiments to original research under rigid surveillance. Professor Dalton seems to think no discussion of the subject is required.* Dr. L. S. Pilcher believes † it only necessary that "the public should be informed of the truth relating to vivisection in order that there should be secured to science every advantage and privilege which its advancement may need." The writer's communication ‡ of two years ago, together with opinions which will be repeated at the close of this article, stated that he had taught physiology for twelve years in a university, and for half that time in a medical school, and yet had never performed a painful vivisection.

Since Cornell University owes its existence largely to the action of the State Legislature, and is bound by its charter to "receive, without charge for tuition, one student annually from each Assembly district," there are peculiar reasons for making known the exact condition of sentiment and practice therein with regard to vivisection. Aside from practical work in the laboratory, the physiological teaching comprises two courses of lectures, special and general. In the former, those who intend to become physicians, or to teach physiology, are made familiar with the details of experimental manipulation. In the latter, the verbal instruction is illustrated by experiments differing little from what are performed in some medical schools. The following are fair selections from these experiments:

1. A frog is killed by "pithing" with a sharp knife, and the brain is destroyed with a piece of wire. The mucous membrane of the roof of the mouth is removed, and the action of the cilia shown in various ways. 2. A frog is rendered motionless by the injection of a little curare under the skin. Two of the toes are tied apart, so as to stretch the intervening "web." The circulation of the blood is then observed under a microscope. Since it is not certain that sensibility is abrogated by curare, the animal is treated just as if it were in its normal condition, to which it commonly returns after a short time. 3. A pithed frog is employed for the demonstration of nervous, muscular, and reflex actions. Although the animal is dead as a whole, the irritability of its muscles and nerves and spinal cord persists for some time after the brain is destroyed or the head cut off. 4. From an anæsthetized frog the brain proper is removed. So long as the medulla remains, the respiratory movements continue; when it

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* In the letter already mentioned, Professor Flint says, "I think investigators and teachers should be the sole judges as to what is necessary in their investigations and teachings."

† "How Vivisection concerns Every Citizen," "Christian Advocate," July, 1880.

‡ "The Two Kinds of Vivisection—Sentisection and Callisection," "Medical Record," August 21, 1880.

is destroyed, they cease. 5. A cat is etherized, inhaling the anæsthetic slowly and without apparent discomfort in a glass box made for the purpose. The trachea is opened, and a glass tube inserted. This is then connected with a U-shaped tube partly filled with a colored liquid; the effect of the respiratory movements in expanding the lungs is shown by the oscillation of the liquid. 6. With an etherized cat the trachea is connected with a pair of bellows. The medulla is cut and the lungs are artificially inflated with the bellows. In this way the heart is kept beating while the entire ventral wall of the chest is removed and the heart exposed to view. If removed from the body, the heart soon ceases to beat. 7. With a cat, anæsthetized and then pithed, the respiratory muscles are stimulated directly or through their nerves. 8. From an anæsthetized frog the cerebral hemispheres are removed. After recovering from the operation, such a frog may remain for weeks in a stupid condition, neither moving nor feeding voluntarily, although it can swim, balance itself on the edge of a board, and swallow food placed in the throat. It thus approximately exemplifies the life of some idiots. 9. A cat is etherized, and part of the right hemisphere exposed. A light interrupted current of electricity is applied to certain spots, and the invariable response is by definite movements of the limbs of the opposite side. Other regions give no response at all. 10. With an etherized cat the vagus nerves are exposed in the neck. A large needle, with a head of red wax, is passed through the skin and muscles, so that its point is fixed in the heart, the pulsations of which are then indicated by the oscillations of the head. When a somewhat strong interrupted current of electricity is sent through one or both of the nerves, the heart beats more slowly, or stops altogether. The current is stopped, and the pulsations recommence. The nerves are then cut, and the heart beats more rapidly, but the respiratory movements are slowed. In this, as in all other experiments under anæsthetics, the animal is killed before revival.

The significance of these and similar experiments may be ascertained from any physiological treatise or well-educated physician. Only the first and the last can be commented on here. Cilia are minute filaments of protoplasm which, among other localities, cover the surface of the membrane which lines the air-passages. Independently of the will they keep up a rapid lashing movement, more forcible in one direction, so that the dust inhaled with the air is continually swept from the smaller tubes into the larger, and so to the larynx, whence it is voluntarily expelled. If we reflect upon the inevitable consequences of a vacation, or "strike," of these millions of irresponsible "sweeps," we shall feel it well worth while to inform ourselves as to their appearance and mode of action, even though the acquisition of this knowledge costs the lives of many frogs. The last experiment affords some clew to the nervous mechanism through which the action of the heart may be accelerated or retarded, or wholly checked on account of violent physical or mental impressions. Who that has felt his heart "flutter," or "stand still," would not, even in a slight degree, fathom the mystery which still surrounds the relations of our bodily organs to each other and to the mind?

Those who denounce all vivisection as "barbarous" are asked to note that the performance of the ten experiments above described involves only the pain of a hypodermic injection or of pithing, since, whenever the animal is alive during the operation, complete insensibility is produced by anæsthetics. Most of the experiments, however, are done upon dead animals—that is, a man treated in like manner would be legally defunct. In the ordinary sense of the word, therefore, such experiments are not vivisections at all, although they are so by virtue of the persistence of vitality in certain organs and tissues.* According to information from various sources, it is probable that the large majority of experiments in this State, whether in medical colleges or other institutions, whether for research or for teaching, are, like those described above, performed upon animals completely anæsthetized or actually dead.†

II. Many persons find it difficult to dissociate the word *vivisection* from the sufferings which were, perhaps, unavoidable before the discovery of ether and chloroform, and from those which are inflicted at the present day by careless or unfeeling experimenters. The proposed laws likewise ignore the difference between experiments in respect to pain. In England the question has been similarly befogged by the use of a single term for two different ideas. In the face of the official reports showing, according to Dr. Gerald Yeo's later estimate,‡ that only twenty-five out of one hundred experiments caused any pain at all, Frances Power Cobbe has the hardihood to say,# "We find it practically impossible to separate torturing from non-torturing vivisection." In view of all this ambiguity, whether due to ignorance or design, I have ventured to suggest ‖ that painful vivisection be known as *sentisection*, and painless vivisection as *callisection*. The desirability of some verbal distinction was presented to Mr. Bergh, both in the article referred to and in private letters, dated February, 1880, and October, 1882. His only reply is the following, dated November 3,

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* It is stated that the Danish Society for the Prevention of Cruelty to Animals has offered a prize for the best essay upon the performance of physiological experiments upon recently killed animals.

† Opinions to the same effect have been expressed by well-known teachers in a sister State, and in Great Britain. In "Scribner's Monthly," September, 1880, page 766, Professor Horatio C. Wood says, "So far as concerns the medical schools of Philadelphia, vivisection without anæsthetics is not practiced to any extent, if at all, for class demonstration." In "The Popular Science Monthly," April, 1874, Professor Michael Foster says, "So far as I know, in this country at least, physiologists always use anæsthetics when they can." See also the very comprehensive and important "Facts and Considerations Relating to the Practice of Scientific Experiments on Living Animals, commonly called Vivisection," issued by the Association for the Advancement of Medicine by Research, "Nature," March 13, 1883, which appeared after this article was in type.

‡ "The Practice of Vivisection in England," "Fortnightly Review," March 1, 1882, pp. 352–368.

"Vivisection: Four Replies," "Fortnightly Review," January 1, 1882, pp. 88–104.

‖ In the article referred to on page 170.

1882: "Pardon me for saying that 'if the rose would smell as sweet by any other name,' surely the blood of tortured animals would also retain its repulsive odor under any other designation." Perhaps Mr. Bergh and Miss Cobbe vaguely apprehend that, should the intelligent people of their respective lands once realize that three fourths or more of what are indiscriminately stigmatized as vivisections are absolutely painless, their denunciations would have little weight, their occupations would be gone.

Specific repressive legislation is commonly directed against the ignorant or the vicious. Laws for the suppression of vivisection stand almost alone as aimed against those who are charged with the mental and physical welfare of the community, and whose official positions and social relations would enable them to further materially the general objects of the Society for the Prevention of Cruelty to Animals. I am not aware of any action upon the part of the teachers of this State respecting Mr. Bergh's efforts to deprive them of the most effective means of illustrating physiology, but the sentiment of the medical profession has been clearly expressed. As stated by Dr. Dalton,* and in the "Medical Record" for February 28, 1880, and February 10, 1883, Resolutions affirming the value of experiments upon animals, and deprecating legislative interference therewith, have been adopted by seven medical schools of the State, by the State Medical Society, and by sixteen organizations representing various localities or special branches of the science. It is hardly to be expected that many physicians † or teachers will enroll themselves under the banner of humanity to animals so long as the same staff carries the black flag of anti-vivisection, which in their eyes is inhumanity to man.

Few educated persons doubt that experimental physiology has practically contributed something to human welfare, and the probability or even possibility that knowledge so gained might save the life or the health of a single child must be felt, at least by the parents of that child, to justify the sacrifice of "a wilderness of monkeys," not to mention lower forms. Naturally, therefore, among the writers in favor of vivisection, nearly all have confined their arguments to the medical and surgical advances which have been made or aided thereby. Some (Dalton, Foster, Leffingwell, and Yeo) have implied, perhaps unintentionally, that physiology appertains only to medical science; while others (Owen, Tait, etc.),‡ defenders as well as opposers of vivisection, exclude it from the category of appliances for instruction. Yielding to none in my conviction of the indispensableness of experiments on animals to the prevention and healing of disease and injury, I believe that a higher and broader ground should be taken. "The knowledge of the human body," whether gained by dissection or by experiment, "belongs to every man, woman, and child, and has no more exclusive connection with physic than with law, engineering, or architecture." Consequently, had vivisection accomplished absolutely nothing for medicine or surgery, nevertheless experiments upon animals, necessarily painful in some cases, should be performed by competent persons for the advancement of physiological knowledge, just as experiments are done in chemical and physical research, and *experiments, commonly painless, should be constantly employed in physiological teaching, simply because the information so imparted is more interesting, more intelligible, and more lasting than what is given in any other way.** The spirit and methods of modern scientific teaching are well conveyed in the motto, "*Iter longum per præcepta, breve per exempla,*" to which may be added the metric imitation of a familiar proverb, "A gramme of experiment is worth a kilogramme of talk." Logically, indeed, unless it be wrong to *kill* animals for the sake of mental acquisition, the exclusion of painless experiments from physiological teaching would be comparable with the abolition of museums, models, and *vivaria* of all kinds because most animals have been figured and described. On this point most persons will admit the force of Dr. Bartholow's query, "If animals are sacrificed for the support of men's bodies, why should they not contribute to the improvement of men's minds?" †

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* "Experimentation upon Animals," chapter iv.

† According to the Report for 1882, the American Society for the Prevention of Cruelty to Animals contains four hundred and two members or donors. *Four* of them are physicians.

‡ Richard Owen, "Experimental Physiology, its Benefits to Mankind," etc., London, 1882; Lawson Tait, "The Uselessness of Vivisection upon Animals as a Means of Scientific Research," "Transactions of the Birmingham Philosophical Society," April 20, 1882; G. F. Yeo, "Vivisection and Practical Medicine," "Popular Science Monthly," March, 1883.

III. "An act for the more effectual prevention of cruelty to animals," passed April 12, 1867, embraces two sections relating to experimentation upon animals:

> SECTION 1. If any person shall overdrive, overload, torture, torment, deprive of necessary sustenance, or *unnecessarily* ‡ or cruelly beat, or needlessly mutilate or *kill*, or cause or procure to be overdriven, . . . or needlessly mutilated or killed, as aforesaid, any living creature, every such offender shall, for every such offense, be guilty of a misdemeanor. . . .
>
> SEC. 10. Nothing in this act shall be construed to prohibit or interfere with any *properly conducted* scientific experiments or investigations, which experiments shall be performed only under the authority of some regularly incorporated *medical college or university* of the State of New York.

The following is the bill for the total suppression of vivisection which has been introduced, at the instance of Mr. Bergh, at the last three sessions of the Legislature:

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* As has been pithily stated by Huxley at the close of an article "On Elementary Instruction in Physiology," "Popular Science Monthly," October, 1877.

† Lecture reported in the "Medical Record," October 11, 1879, p. 342.

‡ Certain words of this and the following extracts are italicized with reference to comments which will be made presently.

> SECTION 1. Every person who shall perform, or cause to be performed, or assist in performing, in or upon any living animal, an act of vivisection, shall be guilty of a misdemeanor.
>
> SEC. 2. The term *vivisection* used in this act shall include every investigation, experiment, or demonstration, producing, or of a nature to produce, pain or disease in any living animal, including the *cutting*, wounding, or poisoning thereof; except when the same is for the purpose of curing or alleviating some physical suffering or disease in such living animal, or in order to deprive it of life when incurable.

Whether or not this law would, or is designed to, interfere with the slaughtering of animals for food, or with the extermination of pests, or even with the drowning or suffocation of impounded dogs under the supervision of Mr. Bergh's Society, does not especially concern physiologists; but the points indicated by the italicized words are worthy of consideration. In the law of 1867, the words *needlessly* and *properly* are used. In the absence of specification as to who shall determine what is needless or proper, would not the decision rest with the administrators and executors of the law? If so, might not the first section be so interpreted as to permit any amount of pain as "needful" for scientific purposes? Other magistrates and police, on the contrary, might deny the "propriety" of any experiment upon living creatures, and thus interdict everything of the kind under the tenth and apparently permissive section. The tenth section expressly restricts even "properly conducted experiments" to medical colleges and universities. Pending the elimination of this impediment to the advancement and diffusion of physiological knowledge by private individuals and by the teachers in the normal and other schools, it is to be hoped that the clause may be interpreted as liberally as are the Sunday laws of the "New Penal Code." The peroration of Mr. Bergh's vivisection address puts the following words into the mouth of a "victim": "If my life be necessary to you, take it." The most natural interpretation of this sentence is that, in the mind of its author, the advancement or dissemination of human knowledge is sufficient justification for putting an animal to death. But his proposed law permits no cutting, wounding, or poisoning excepting for the sake of the animal itself. What are we to understand upon this fundamental question?*

Respecting the last section of the law of 1867, Mr. Bergh says,

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* On the 23d of December, 1882, I addressed Mr. Bergh a letter asking whether his bill is designed to prohibit the following operations: confining the animal with cords or bandages; subcutaneous injection of curare; killing by pithing; experimenting under anæsthetics, the subject being killed before revival; experimenting under anæsthetics, the animal being allowed to revive, and to endure the healing of clean incisions. Notwithstanding a later request for attention, no reply has been received.

"So long as this remains unrepealed, these scientific horrors, which I hold to be an insult to the Deity and to the civilization of our generation, will proceed." * Let us see what facts Mr. Bergh has to offer in support of so decided a condemnation. Of his Vivisection Address, several pages are occupied with descriptions of more or less cruel European experiments, and with lurid comments thereon; *a single page is devoted to a single New York case.* Immediately after dwelling at some length upon the atrocities perpetrated in the veterinary school at Alfort, in France, he says: "Those of you who have been able to listen to the recitals I have just made, will, perchance, experience a glow of national pride at the thought that such devilish deeds are impossible in this happy land of yours; but your self-gratulation is but partially true, as I have lately had occasion to verify. On the 19th of December, 1879, I dispatched an officer of the society I represent to attend an exhibition of a similar sort at one of the colleges of the city of New York. . . . A live dog was brought in, said to be under the influence of an anæsthetic." The rest of the description indicates that the experiment was the same as No. 6 of those mentioned upon page 171. So far, therefore, as depends upon the evidence furnished by Mr. Bergh, to evoke the law for the suppression of vivisection in the State of New York, because formerly anæsthetics were unknown, and because in France they are still too often unemployed, is as if an army were summoned for the extermination of the panthers in the "North Woods," upon the pleas that they were numerous and dangerous not many years ago, and that at the present time in India thousands of people are annually slain by tigers.

So far as I can ascertain, Mr. Bergh is not only the originator and instigator of the anti-vivisection legislation in this State, but almost its sole supporter. No articles by members of his society have come to my notice. According to the "Medical Record" for March 13, 1880 (page 292), in that year but a single vote was cast in the Assembly against the acceptance of the adverse report of the committee to which his bill had been referred. Its fate at the last session is thus announced in the Annual Report of his Society: "That sum of all physiological villainy, vivisection, which I again recommended to the consideration of that sapient State congress which was characterized by a portion of the press as a 'mob,' has been remorselessly, and at the bidding of a heartless and opinionated medical faculty, disrespectfully slaughtered as before."

Nevertheless, in a letter dated November 24, 1882, Mr. Bergh says, "I am not quite sure whether I shall introduce a vivisection bill at the ensuing session"; and in view of what has taken place in England, at first sight a most unlikely nursery for any movement in behalf of animals, it may be well to consider somewhat carefully his qualifications for leadership in a movement of such importance.

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* Vivisection address, 1880, p. 24.

IV. The experiment above mentioned is characterized by Mr. Bergh as "the crucifixion of a sentient, unoffending being, . . . an immortal work of the Deity." The grave question of the immortality of animals need not be discussed here. The adjective *unoffending* is objectionable merely because, like so many other words used by the same writer, it tends to throw a sentimental film over the eyes of logic and severe justice through which the whole matter should be viewed, and it is altogether probable that the dog thus utilized for the exemplification of several important physiological truths was, like most vivisection "subjects," a worthless street cur whose death, in the manner described, was a relief to the community, and a positive deliverance from a worse fate through hunger or cold, or at the hands of ill-regulated boys. But, in the entire absence of evidence that the animal was conscious, the use of the words *sentient*, *crucifixion*, and *exhibition of a similar sort* constitutes an exaggeration so great and so mischievous that it can not be lightly passed. It is akin to affirmations in other parts of the address: "The effect of curare in itself is horrible beyond conception; . . . it is an error to suppose that anæsthetics subdue completely the pain of operations; . . . the hands of the preceptors in our medical colleges are daily incarnated with the warm blood of tortured animals ruthlessly slaughtered." If, with Huxley, we hold that "the assertion that outstrips evidence is not only a blunder but a crime," the offenses of Mr. Bergh are too many for enumeration here.

The "quotations" upon which Mr. Bergh bases the surprising claim * that "vivisection has been the subject of universal condemnation by the more eminent members of the medical profession in Europe," have been scrutinized by Dr. Dalton.† After showing that Professor W. B. Carpenter expressly repudiates the views attributed to him, Dr. Dalton inquires: "What shall we call this manipulation of the facts used to convey an impression at variance with the reality? If we did not know that it came from a professional philanthropist, we should be inclined to give it a very awkward name." Again: "If confinement in State-prison were the legal penalty for tampering with an author's opinions and falsifying his language, I am afraid Mr. Bergh would have been there long ago."

It can hardly be denied that, taken by themselves, some of Mr. Bergh's affirmations and accusations suggest that his hatred of vivisection is stronger than his love for courtesy and truth, and if the argument *sævus in Europa, sævus in America*, which is really all he has to offer against New York physiologists, were turned against him in the original form of *falsus in uno, falsus in omnibus*, the advocates of unlimited dog-fights and cocking-mains might well object to the recognition of such a witness against their favorite sports. But, when all else is considered, the evidence proves too much. The man of pure and upright life; the heroic defender of the weak against the brutal; the tireless organizer of a society, for the main object of which he has secured legislative and legal co-operation, and the sympathy of the better part of the community, surely such a man can not be a common scold and an habitual liar.

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* "Memorial to the Legislature," 1880, section 5.

† "Mr. Bergh as a Commentator," "The Nation," October 16, November 6 and 20, 1879.

Is there a less harsh alternative? After thoughtful consideration of nearly all Mr. Bergh's published writings, and of several courteous private letters, I conclude that, in regard to experimentation upon animals he is not morally perverse, but mentally incapacitated for accurate observation, correct quotation, logical argument, or legitimate conclusion; that, in short, so far as vivisection is concerned, he is of unsound mind.* This charitable view of his character may serve to explain passages like the following: † "As another proof of the profane extremes to which these dissectors of living animals will go, Robert McDonald, M. D., declared that he had opened the veins of a dying person, remember, and had injected the blood of an animal into them, many times, and had met with brilliant success. In other words, this potentate has discovered the means of thwarting the decrees of Providence, where a person was dying, and snatching away from its Maker a soul which he had called away from earth." ‡

In view of all these things, is Mr. Bergh's single-handed crusade against practical physiology anything more than an unintentional burlesque of reform? Is it compatible with the highest usefulness of the society which he represents or with the dignity of the Legislature of a great State that he should be permitted to repeat the fiasco? Should he persist, in open disregard of his own dictum, "Laws can not precede public opinion, but must be the outgrowth of that opinion," the interests of humanity in its widest sense would certainly be promoted in this State by the authoritative assurance that his extreme views are not shared by the American Society for the Prevention of Cruelty to Animals.

V. The concluding division of this article combines: A. A summary of the facts and views already presented; B. A brief statement of certain matters which could not be fully discussed on this occasion; C. An expression of what I believe to be the sentiment of unprejudiced, humane, well-informed persons respecting the legitimacy of experiments upon animals and the desirability of legal interference therewith.

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* This idea is suggested, perhaps without design, in Dr. Dalton's characterization of Mr. Bergh's attack upon Magendie as "crazy maledictions." "Magendie as a Physiologist," "International Review," February, 1880.

† Vivisection address, p. 15.

‡ See also his letter respecting experiments upon transfusion, "New York Evening Post," Feb. 28, 1883.

1. The object of an experiment may be the advancement of knowledge by research, or its diffusion by teaching.

2. In respect to the infliction of pain and death, experiments are of four kinds: (1.) The animal has been recently killed; (2.) The animal is rendered insensible by anæsthetics and killed before revival; (3.) Anæsthetics are used during the experiment, but the animal revives and endures the healing of wounds; (4.) Without anæsthetics, the animal is subjected to cutting operations, or to the effects of poisons or of insufficient food.

3. All experiments at Cornell University belong to the first two groups. Of all the experiments performed during the past year in the State of New York, whether for research or instruction, probably less than one tenth would come under the fourth class, and not more than one tenth under the third. In view of what is learned from these experiments, the total amount of pain and death inflicted is insignificant.

4. It is desirable to make a verbal distinction between painful and painless experiments, and to adopt a single term in place of the phrase experimentation upon animals.*

5. Over and above the utilitarian argument drawn from its subserviency to medical science, physiology should be pursued and illustrated experimentally like chemistry or physics, because it is a most interesting and suggestive branch of knowledge.

6. In the State of New York are very few men whose natural and acquired powers of body and mind qualify them to determine when painful experiments are required, to perform them successfully, and to wisely interpret the results. Such men, deserving alike of the highest honor and the deepest pity, should exercise their solemn office not only unrestrained by law, but upheld by public sentiment.

7. All teachers of physiology, from primary schools to universities, should illustrate their instruction by experiments upon animals, chiefly if not wholly painless.

8. All experiments should indirectly inculcate humanity to animals. The victims should be treated with respect on account of what is learned from them, and with gentleness because "cruelty to animals is the beginning of cruelty to man." Even the administration of anæsthetics should cause the least possible discomfort.

9. The abolition of vivisection in the State of New York is demanded by a single individual, who has not as yet displayed the necessary qualifications for dealing with so large a problem. The laws proposed by him are vaguely framed, and inconsistent with his own utterances upon the subject.

10. A single physician has advocated legal restriction of painful

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* Such a term is zoöpery, from the Greek ζοον, *an animal*, and πειραω, *I experiment*. By inflection we get *zoöperal, relating to experimentation on animals, and zoöperist, one who performs such experiments.* In this connection, it is to be noted that many experiments are upon dead animals, and some involve no cutting at all.

experiments. Otherwise, so far as appears from published resolutions, legislative interference is opposed by the medical profession of this State.

11. Judging from English experience, the interdiction of all vivisection would seriously impede the progress of physiology in this State.

12. While physiologists justly resent attacks grounded in ignorance and maudlin sentimentality, they should avoid and discountenance even the appearance of bravado and indifference to the suffering of animals.

13. So long as the people and the Legislature are satisfied that physiological investigators and teachers regard the infliction of pain as undesirable on every account, no legal restrictions are likely to be put upon vivisection in the State of New York.

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QUARTZ: ITS VARIETIES AND FORMATION.

By Rev. J. MAGENS MELLO, F. G. S.

QUARTZ is in its many forms probably the most abundant, as well as one of the most beautiful, of all the various minerals which enter into the formation of the earth's rocky surface. To describe it and its principal varieties, and to give a short sketch of the modes of its occurrence and of its formation, will be the object of this paper. Among the elements known to chemistry is one named silicon, sometimes called silicium; the oxide of this substance, which is never found in a free state in nature, constitutes silica, the chemical name for quartz and all its varieties. Its pure crystallized form is familiar to us as the colorless and transparent rock-crystal.

As rock-crystal, the typical form of quartz, is an hexagonal prism terminated at each end by a rhombohedron, when broken it will be seen to have a conchoidal or splintery fracture. Rock-crystal is very widely distributed, being found in rocks of all ages. The most beautiful and perfect specimens are usually obtained from large cavities or geodes in the older igneous rocks, and also from veins in these and other rocks. The size and color of quartz-crystals vary greatly; some are so small as to be microscopical, while others are of very considerable bulk. In the museum of Berne may be seen specimens of both the clear rock-crystal and also of black or smoky quartz upward of a foot in length; there are also some very large ones in the British Museum. Quartz-crystals are often found presenting almost every shade of color—yellow, brown, black, red, blue, violet, and green. Various names have been given to these colored varieties. The violet, blue, and some of the yellow, and even of the white crystals, which, when fractured, are seen to have a peculiar undulated structure, which Sir D. Brewster pointed out, have been classed together as amethysts, a name often popularly restricted to the violet crystals, which owe their beautiful tint to the presence of oxide of manganese. Violet amethysts are not uncommon in the geodes occurring in volcanic rocks in many localities; but the finest are obtained from Siberia, Persia, India, and Ceylon; while Brazil yields white and yellow amethysts. The yellow and brown crystals known as cairngorms are varieties of rock-crystal or of crystallized quartz, if we restrict the term rock-crystal to the clear, colorless specimens. The darker brown and black crystals, as well as those designated as cairngorms, may be grouped under the common name of smoky quartz. The dark-green quartz is called prase, and is colored by amphibole; there is also a lighter green species known as chrysoprase, tinted, it is said, by oxide of nickel; while oxide of iron probably gives color to the numerous red varieties. The common milk-white quartz, which is the ordinary quartz of veins and of quartz-rock, will be found, on microscopical examination, to be really transparent, but so full of minute cavities as to cause it to assume its milky opacity.

Quartz-rock, or massive quartz, is often found in mountainous masses, hundreds of feet in thickness. Many of the quartz schists and micaceous schists consist chiefly of quartz irregularly split up by thin leaflets of mica. Sandstone rocks, often consisting of little besides more or less rolled grains of quartz, will have been derived from the breaking up, under various denuding agencies, of rocks in which quartz has been the prevailing mineral. Veins of quartz have already been mentioned. These are very frequent in the old slate and schist rocks, sometimes forming broad and irregular bands; at others, mere threads traversing the other materials. Such veins will often present open spaces in which the quartz will be found regularly crystallized.

Flint and chert are forms of quartz usually occurring as concretions in limestone rocks; sometimes, however, as bands of considerable thickness. The black color so common to the flints of the chalk formation and to the chert nodules and bands in the mountain limestone is due to the presence of carbon. Hornstone is merely a variety of chert.

Chalcedony has been described as a mixture of crystalline and amorphous quartz; its tendency is to assume a botryoidal or stalactitic form; and its numerous variations of color and modes of occurrence have led to the adoption of different distinguishing names. Carnelians and sardes are only color distinctions of chalcedony; and the immense family of agates, including the onyx and sardonyx, is more or less composed of chalcedony, disposed in layers, regular or irregular, and combined with other forms of quartz, such as amethyst, jasper, etc. This latter name is applied to an aluminous variety of quartz: it is opaque, and has a less crystalline appearance than ordinary quartz. It is very varied in color: some beautiful red, brown, and green-banded stones are obtained in Siberia, in Egypt, and elsewhere. Bloodstone is considered to be a mixture of chalcedony and jasper, colored by metallic oxides. One of the most beautiful forms of quartz is opal, which is nothing more than amorphous silica combined with water, which has filtered out from the rocks, usually igneous ones, and is found in cavities and fissures in those rocks. Bohemia, Hungary, Auvergne, and Queensland yield opals, some of them of great beauty and value.

Having thus briefly pointed out the principal varieties of quartz, and the modes of their occurrence, we will next turn to the history of their formation. We shall find that quartz may have been formed by more than one process in the grand laboratory of Nature. According to Cotta, there are two modifications of chemical composition in quartz, which are distinguished by their different degrees of solubility. "The one is insoluble in water and in every acid except hydrofluoric, and the other is soluble in water at high temperatures, especially in the presence of other acids and alkalies." The insoluble variety of quartz may, it is said, in process of time become "converted into the soluble by the contact-influence of infiltrated moisture." It may, however, be noted that ordinary quartz, if fused with carbonate of soda, becomes soluble in water, and from this solution gelatinous silica is precipitated by hydric chloride. Years ago it was noted that silica when combined with an alkali is soluble in water, and that thus the decomposition of feldspar might in some instances be a source of silica in solution. The residue of decomposed feldspar, when it has been examined, has been found to contain only a portion of the silica due to it, the remainder having been dissolved. In a similar manner mica is another mineral which may be a source of supply for pure silica. A fact of some importance in studying the mode of the formation of quartz is that, unlike feldspar and other minerals, which in crystallizing pass at once from the fluid to the solid state, quartz passes through an intermediate viscous or colloid condition before it assumes the crystalline form. It is, comparatively speaking, only very recently that we have had any practical acquaintance with this colloidal form of silica. The late Mr. T. Graham, by his most valuable experiments in dialysis, succeeded in obtaining pure silica dissolved in water, which rapidly assumed a gelatinous condition.

The three principal agencies that have taken part in the formation of quartz are heat, water, and organic life. When we examine, by the aid of the microscope, certain forms of quartz, such, for instance, as the crystals occurring in some of the quartz porphyries, and occasionally in the pitchstones, as well as much of the quartz of granite rocks, we find that they contain minute cavities which inclose very frequently tiny crystals of other minerals; in the quartz of granite these are very often found to be alkaline chlorides, or sometimes the cavities are filled up with glassy mineral matter—as, for instance, in the quartz of some of the Icelandic trachytes. Other cavities are found, especially in the granitic quartz, filled with gas, or sometimes with water, or liquid carbonic acid. In these latter cavities small bubbles will be found which are movable; the smaller ones, indeed, appear to be endowed with a kind of perpetual motion of their own. The quartz in these rocks must have crystallized at a very high temperature—indeed, where glass cavities occur, from a state of true igneous fusion. Mr. Sorby has shown that the solvent power of liquid water at the temperature of about 412° C. is very great: its action on glass has been such as to produce quartz-crystals from it.

There seems to be clear proof that the quartz of the granite rocks which contains partially filled fluid cavities, and cavities inclosing crystals of common salt, etc., has been formed in a partially melted mass of rock, and began to crystallize when that mass was exposed to the solvent action of liquid water, at a temperature not far below 400° C., but yet not sufficiently high to expand the water into steam. Mr. Sorby concludes that "by far the larger part of the quartz in granitic rocks was set free and crystallized through the action of liquid water, at a temperature of a dull-red heat, just visible in the dark. The exact temperature may, however, have varied considerably, since, if the pressure were not sufficiently great, the water might remain in the form of steam until the rock had cooled somewhat more." It has been noticed as somewhat remarkable that the quartz in granite should have been usually the last mineral to crystallize, although it is that one which is the most difficult to fuse, and which would therefore naturally be expected to have been solidified before the feldspar and the mica. But it has been shown that, when quartz is in combination with other mineral substances, it is often as readily fusible as they are; and thus what must be called accidental circumstances may have led, in the case of the rocks in question, to its being crystallized after the feldspar, which we so generally find to have modified the form of the quartz; this latter appearing as a glassy paste inclosing the accompanying minerals, instead of having a definite form of its own. It has also been observed that the feldspar in solidifying would liberate a sufficient quantity of heat to enable the quartz to retain its viscous state (Durocher); just as, on the other hand, in the quartz porphyries we see an instance of the analogous effect of the crystallizing quartz upon the feldspar. It is asked how the enormous masses of quartz which form some of the schistose rocks can have been produced? We must appeal to metamorphism. The contact of highly-heated eruptive matter might thus alter a quartz or sandstone into an almost pure quartz-rock. Heat and pressure combined are mighty agents, which might also effect a similar change during the course of long ages.

That water at a high temperature can hold quartz in solution is well illustrated by the deposits of silicious sinter, thrown down by thermal springs, as, for instance, the geysers of Iceland, and by others in Kamchatka and in New Zealand: this silica often incrusts mosses and other substances in the same way that we may see calc-tuff forming petrifactions in other localities. The delicate, feathery crystallizations of silicious sinter are extremely beautiful.

The quartz of veins appears generally to have been deposited from aqueous solution, and will be seen, as has been already remarked, to contain innumerable cavities inclosing water. Occasionally these watery cavities are of large size, and may be observed without any instrumental aid.

Among the most varied and beautiful forms of quartz which have had a purely aqueous origin are all the varieties of crystalline and amorphous silica, which frequently coat the interiors of geodes and other hollow spaces in the igneous rocks, and which consist chiefly of an intermingling of chalcedony and jasper, and are conveniently grouped under the general name of agates. Pure rock-crystal, amethyst, cairngorm, and other valuable crystallized forms of quartz, are often found in connection with the same rocks, or in others of a more purely metamorphic character. All these varieties of quartz are secondary formations, deposited from watery solutions. The exact mode in which agates have originated is a question full of interest, and not easy in every case to answer. A wonderful history of mineral growth is written in the folded leaves, if one may so denote the bands of a single agate. A very large number of agates consist of more or less concentric layers of chalcedony of various colors (the colors depending on the presence of metallic oxides), together with jasper, rock-crystal, amethyst, etc., in many cases.

Chalcedony is sometimes described as a reniform condition of silica, and though apparently amorphous, when it is microscopically examined, it generally, if not always, exhibits a minute and definite radiated crystalline structure. It frequently forms stalactites, and many of the most exquisite of the banded agates are sections cut from stalactitic formations. Jasper may be looked upon as chalcedony, which, as it consolidated, caught up a certain amount of alumina, or sometimes of lime or oxide of iron. Professor Ruskin, who has paid some attention to this subject, has observed that "jasper will collect itself pisolitically out of an amorphous mass into a concretion round central points, but does not actively terminate its external surface by spherical curves; while chalcedony will energetically so terminate itself externally, but will, in ordinary cases, only develop its pisolitic structure subordinately, by forming parallel bands round any rough surface it has to cover, without collecting into spheres, unless provoked to do so by the introduction of a foreign substance, or encouraged to do so by accidentally favorable conditions of repose."

According to the same observer, some agates appear to be of the nature of concretions formed from within, round a nucleus; these would consist of chalcedony or jasper in the inner portions, and have distinctly crystallized exteriors. There is another class of agates composed of external bands of chalcedony or jasper, stalactitically deposited in a cavity which may either have a hollow center, or one filled up with crystals of quartz. There appear, however, to be intermediate varieties in which concretionary or stalactitic formations have been combined with, or interrupted by, other modes of growth.

Some of the most curious and beautiful agates are those containing dendritic crystallizations; in these we see, in the more or less transparent chalcedony, which in these agates is not banded, wonderful mossy or confervoid-like growths, often very closely resembling vegetable forms. The valuable stones from Mocha contain ferruginous brown or black inclosures, while some of the dendritic agates from India are filled with a bright-green network of what appear to be filaments of confervæ. These dendritic forms in the moss-agates are mostly the oxides of iron or manganese; or in the green Indian pebbles, delessite or chlorite. The question of their origin is a difficult one. In some agates the dendrites may have resulted from a segregation of the oxides of the metals from the colloid or partially crystallized silica; in other cases they may be the effect of subsequent infiltrations; or, again, the quartz may have been consolidated around previously existing crystallizations. With regard to infiltration by these oxides, it is well known that even the most compact-looking chalcedony is permeable, as it is possible by steeping it in solutions of the aniline or other dyes to impart the most brilliant tints to agates, the dye undoubtedly gaining access to the interior of the specimen through the interspaces of its minutely crystalline structure.

In a large group of agates, of which beautiful specimens come from India, an appearance of banded formation is seen, which, upon microscopic examination, resolves itself into an infinite number of red or brown spots, regularly arranged in bands or concentric groups: these spots appear to be segregations of oxide of iron. I have not seen a specimen of this species of agate cut sufficiently thin to show whether the arrangement of these minute spots is dependent upon a banded structure in the chalcedony itself, or whether it is independent and the result of molecular force which has determined the arrangement in question. It may here be noticed that a vast number of the Indian agates come from the neighborhood of the Gulf of Cambay. Near Turkeysar there are agate conglomerates intercalated between beds of laterite which belong to the Eocene period. These conglomerates we may suppose to have been derived from the denudation of the earlier igneous rocks which abound in the same district. Uruguay, in South America, also produces a large number of remarkably fine banded agates. Sometimes well-formed quartz-crystals will be found inclosing other substances, which, in some instances, have been caught up by the crystals in the course of their formation, or have crystallized, perhaps, almost simultaneously with the quartz. In other cases the quartz is proved to have crystallized over other previously-formed crystals; thus schorl is occasionally seen partially inclosed in quartz-crystals and partially free, the ends of the crystals of schorl projecting through the quartz. Titanite, asbestus, and other minerals are not unfrequently found in minute acicular forms in quartz. The quartz in the igneous rocks may frequently be seen to inclose crystals of feldspar or titanite, or portions of the matrix which must have been previously solidified.

Opal, as has already been pointed out, is a product of aqueous origin found in the fissures and amygdaloid cavities of igneous rocks. Its wondrous play of colors has given rise to much discussion by Brewster, Des Cloiseaux, and other writers. Some have attributed it to the presence of numerous cavities of varying size, which cause a kind of iridescent refraction. Des Cloiseaux was inclined to suppose that organic matter might be inclosed in small quantities in its cavities. The most reasonable supposition, however, appears to me to be that of Reusch—that light reflected or transmitted from numberless flaws in the mineral gives rise to the phenomena in question through a process of double refraction.

We may now turn to the consideration of forms of quartz which have a more or less organic origin. At the head of these may be placed such undoubtedly organic aggregations of silica as the Tripoli and semi-opal of Bohemia, which consist almost entirely of fossil diatomaceæ. Some beds of rock also in the Island of Barbadoes are found to be composed of little else than polycystinæ and spiculæ of sponges. Much of the flint so characteristic of the chalk-rocks, as well as the chert of the greensand and of the mountain limestone, appears to have been derived from the precipitation, by organic substances, of silica held in solution by the waters of the ocean; at any rate, much of it seems to have been thus deposited; flinty nodules are often found to consist of fossilized sponges, the silicious skeletons of which may have attracted to themselves the silica dissolved in the surrounding water. Spiculæ of sponges, diatomaceæ, foraminifera, shells, corals, and other organisms are abundant in the flint, and also in much of the chert. Recent observations by MM. Guignet and Teller have shown that the water of the Bay of Rio de Janeiro contains large quantities of both silica and alumina in solution, the amount in the case of silica being as much as 9·5 grains per cubic metre.

Wood will sometimes be found to be pseudomorphosed into silica, the woody structure being replaced atom by atom, so that the minutest vessels are perfectly preserved. Various species of palm from the East Indies are frequently found fossilized in this manner, and sections of them make very beautiful objects for the microscope. Large fragments of a partially silicified wood, named *Endogenites erosa*, may often be found in the neighborhood of Hastings, derived from the wealden formation.

The curious so-called mineral beekite is really coral or shelly matter which has been replaced by silica. Researches into the behavior of the colloid form of silica, already spoken of, have shown how in many instances large deposits of silica, such as the flinty bands of the cretaceous formation, may have originated. Mr. Church's experiments, made some years since, proved that the minutest particle of carbonate of lime was sufficient to transform the pure aqueous solution of silica into the solid state in the course of a few minutes; and he was able, by the infiltration of silica in solution, to replace almost entirely the carbonate of lime in recent coral by silica, producing by this means what may be looked upon as a kind of artificial beekite. Thus in the slower, perhaps, but mighty chemistry of nature, marvelous reactions may have taken place, giving rise to some of the multitudinous forms in which silica presents itself to the mineralogical student.—*Science-Gossip.*

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M.D.

CONSUMPTION (*Concluded*).

THE MOUNTAIN-CURE.

CARBONIC acid, the lung-poisoning residuum of respiration and combustion, is heavier than the atmospheric air, and accumulates in low places—in wells, in cellars, in deep, narrow valleys, etc.—and often mingles with the malarious exhalations of low, swampy plains. On very high mountains, on the other hand, the air becomes too rarefied to be breathed with impunity. It accelerates the respiratory process, as the amount of air inhaled at one inspiration does not contain oxygen enough to supply the wants of the organism at the ordinary rate of breathing, and is therefore especially distressing to diseased (wasted) lungs, whose functions are already abnormally quickened, and can not be further stimulated without overstraining their mechanism.

In the temperate zone, the purest and at the same time most respirable air is found at an elevation of about four thousand feet above the level of the sea, an altitude corresponding to the midway terraces of the European Alps and the average summit-regions of our Southern Alleghanies. The broad table-lands of the Cumberland Range are several hundred feet above the dust-* and-mosquito level.

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* While the treeless plateaus of the Pacific slope are in a chronic state of sand haziness. In Southern Colorado, too, every high wind shrouds the mountains in whirls of a kind of sand-dust that can be felt under the eyelids and between the teeth.

Between the thirty-fourth and thirty-sixth degrees of north latitude the elevated plateaus have the further advantage that their climate equalizes the contrasts of the season: it mitigates the summer more than it aggravates the winter. Southerly winds predominate, and melt the snow with the same breezes that cool the midsummer weeks, for in the dog days the Mexican table-lands are considerably cooler than our Northern prairie States. In the Alps of North Carolina, Tennessee, and Northern Georgia land and labor are so cheap that even people of moderate means can build a sanitarium of their own. It has been often observed that the moral effect of a residence at a place where consumptives congregate is not favorable to the cure of the disease; and, moreover, a private establishment lessens the danger of contagion. The cheapness of living may be inferred from the fact that at the Chalybeate Springs of Benton, Tennessee, where board-rates vary from fifty to seventy-five cents a day, the visitors from the surrounding country towns, nevertheless, prefer to board on the co-operative plan: the proprietor of a kitchen-garden furnishes vegetables, a stock-farmer fresh meat, the owner of a carriage free transportation, and every family has a little cottage of its own. Summer-guests who come to drink mountain air can build their cabins wherever they find a convenient plateau, and contract with the next farmer for all the comestibles they may need in addition to their canned provisions. They can cook at their own fireplace. A log-house can be made as airy as any tent, and is out and out more comfortable. A rough-hewed porch-roof, projecting like the veranda of a Swiss *chalet*, will keep the cabin both dry and airy; square holes in the center of each wall can serve as windows in fine weather, and during a storm can be shut with a sliding-board. Between May and November the winds in the Southern Alleghanies come from the south or southwest, nine days out of ten, and, in order to get the full benefit of the pure air, the house should face one of the thousand promontories of the southwestern slope that rises in terraces from the "Piedmont counties" of North Carolina and Northern Georgia, with a free horizon toward the plains of the Gulf-coast. Have the door on the south side, and keep it wide open all night, as well as the windows or louvers in the opposite wall. If the windows do not reach to the ground, spread your bedclothes upon a hurdle-bedstead rather than on the floor, in order to enjoy every afflatus of the night-breeze. Night and day one can thus breathe mountain airs that have not been tainted by the touch of earthly things since they left the pine-forests of the Mexican Sierras. Every inspiration is a draught from the fountain-head of the atmospheric stream.

There is no need of living on oiled sardines where the brooks are full of speckled trout. Those who *must* break the commandment of Brahma (and the highland air confers certain immunities), may devour their humble relatives in the form of wild-turkeys, quails, and opossums; but the products of the vegetable kingdom are cheap, and diversified enough to make up a tolerable *menu.* Sweet-potatoes at twelve cents a peck, string-beans fifteen, green peas twenty-five; strawberries ten cents a quart, roasting-ears a cent a piece, brown beans actually a bushel for one dollar—Dalton (Georgia) market-prices. "Semi-annual" comestibles in proportion: eggs eight cents a dozen, butter twenty cents a pound in mid-winter, and ten cents in summer. Milk is a drug in the market; a good milch-cow can be hired for a dollar a month, a cow-boy for two dollars and his board. Whortleberries are sold at five cents a quart, but the pleasure of picking them is worth a great deal more. The lamest and weakest can join in that sport, for the shrub attains a height of three feet, and thus saves one the trouble of stooping.

About an hour after breakfast the colony (or family) should muster for out-door exercise. The choice between the various opportunities for entertaining work is the only difficulty, for Nature has provided them in embarrassing profusion. Expert bee-hunters can find four or five hive-trees in a single day. The chestnut-forests of the upper ridges are full of squirrels, and with a dog, a sack, and a good axe, it is not difficult to catch one alive, and turn it over to the quartermaster of the pet-department. Climbing trees is an exercise that brings into action nearly every muscle of the human body, and, like the *mal de monte,* the shudder that seizes the traveler at the brink of Alpine precipices, the dizziness that takes away the breath, returns it with interest and is a mechanical asthma-cure. Entomologists may combine the gratification of their mania with useful exercise by rolling logs in quest of big-horn beetles. Log-rolling and tumbling rocks from the tops of projecting cliffs is the spice of life in the engineering enterprises which a campful of male North Americans are sure to set afloat—as enlarging the entrance of a cave, constructing a graded trail to the next spring, to the next wagon-road, or to a favorite lookout point. Enterprises of that sort involve a good deal of grubbing and chopping, but also many interesting discoveries—geological specimens, an unknown chrysalis, new varieties of ferns and mosses. As the work progresses it becomes a pastime rather than a task, and novices feel inclined to agree with engineer Spangenberg, that "with a little management a first-class railroad can be built to any point of the continent earth." There is no cliff that can not be circumvented or terraced. With a slight curve in the road an apparent obstacle can be utilized as a bulwark. In fallen trees the removal of a few side-branches develops revolving faculties. A pickaxe makes a whole wilderness plastic.

The summer air of the highlands makes out-door life a luxury, but the chief advantage of the plan is this: The stimulus of a pleasant pastime enables a man to beguile himself into about ten times as much exercise as he could stand in the Turner-hall. The visitors of a hygienic gymnasium take their turn at the horizontal bar as they would swallow the drugs of a public dispensary: they know that it is a lesser evil, they know that the road to Styx is the alternative, they intend to come every day, but the intolerable tedium of the crank-work exercise soon shakes that resolution. The motive for exertion is too abstract; it lacks the charm of progressiveness and the stimulus of a proximate, tangible, and visible purpose. The sham competition of a regiment of invalids under the command of a *turn-master* does not much sweeten the bitter broth; it is still crank-work, minus the club of the jailer, and nine out of ten hygienic gymnasts will soon find or make a pretext for discontinuing their visits. How many out of a hundred pupils of a young ladies' seminary would dream of performing their "callisthenics" at home? They would as soon walk on all-fours, or ride on a dry clothes-line. But arrange a May-day picnic in the mountains, and they will beat a kid in climbing up the steepest rocks, and swing on wild grape-vines for hours together.

It is likewise certain that fatigues can be far better borne if the body is not encumbered with a surplus of calorific clothes. A pair of linen trousers, a flannel hunting-shirt, and a loose necktie, make the most hygienic summer dress. In the afternoon remove the necktie and roll up the shirt-sleeves: it can do no harm to imbibe fresh air by all available means, and let the cutaneous lungs share in the luxury. Nor is there any excuse for the wide-spread fallacy that it is dangerous, even in the most sweltering nights, to remove the bed-blankets. Kick them into the farthest corner if they become too warm, and sleep in your shirt and drawers, or under a linen bed-sheet. Half-naked lazzaroni sleep the year round on the stone terrace of the Museo Borbonico and outlive the asthmatic burghers in their sweat-box dormitories. The body effects part of its breathing through the pores. Painting a man with yellow ochre and copal-varnish would kill him as surely as hanging him by the neck. The confined air between the skin of the body and a stratum of heavy blankets gets gradually surcharged with carbonic acid—in warm weather even to the verge of the saturation-point. The perspiration is thus forced back upon the body; and the lungs—perhaps already weakened by disease—have to do double work.

Hunters may find it hard to return in time for dinner, and need a rallying-signal. One P. M. is a good time for a general shouting-match. Wake the echoes of the old mountains; the spirits of the departed Cherokees are tolerant—offer a premium for the loudest and ghastliest war-whoop, and depend upon it that no pulmonary disaster will spoil the triumph of the victor. Blood-vessels are not ruptured in that way, but by sudden movements or abrupt ejaculations, when terror or a similar emotion has driven the blood back upon the heart. But, while the mind is at ease, and the lungs not strained by a desperate exertion of the pectoral muscles, I would defy a consumptive to yell himself into a hæmorrhage. A vocal effort does not injure the respiratory organs; on the contrary, it strengthens them. Statistics show that lecturing and preaching *savants* outlive their graphic colleagues. In Carrollton, near New Orleans, I knew a hectic old Mexican banana-vender who was so short of breath that he had often to clutch the legs of his chair in his dire struggles for life-air, and who told me that every few days or so he had to hitch up his market-wagon, and bawl out his wares at the top of his voice, and for hours together—*in order to ease his lungs.* Intead of speaking in a whisper, consumptives should envy cattle-drivers, whose business gives them a plausible pretext for yelling.

The prejudice against after-dinner speeches is founded upon a more valid reason. Rest, mental and physical, is really a prime condition of a thorough digestion. Invalids, especially, need a liberal *siesta*, and a two hours' nap in the shade of a shelving rock can do no harm. Long, sultry afternoons, though, are unknown in the highlands, and before 3 P. M. the air will again be cool enough for any kind of outdoor sport. If the spring needs cleaning out, a wheelbarrow full of flat rocks from the next creek will turn it into a deep, limpid *brunnen*, where a pail can be filled at a single dip. On sunny days butterfly-hunters may bag their game on every mountain-meadow. Grasshoppers can be flushed by the dozen, and make the best bait for brook-trout. The rock-benches at the water's edge would invite to a prolonged session if other pastimes were not too tempting and numerous. There are raspberries and muscadines in the brake; farther up the woods are strewed with chestnuts, and the collector soon learns to find the little dells where they accumulate, like nuggets in the cavities of a California gold-creek.

It is astonishing how work of that sort makes the hours vanish, together with many evils which tedium is apt to aggravate: languor, spleen, and dull headache. But more wonderful yet is its effect on the disorders of the respiratory organs. Under anything like favorable circumstances the lungs are, indeed, the most *curable* part of the human body. With every inspiration the balm of pure air can be brought into contact with the thousand times thousand air-cells of the respiratory apparatus,* and, as we breathe about twenty times per minute, the panacea can be applied twenty-seven thousand times in twenty-four hours. Every day six hundred and eighty cubic feet of gaseous food circulates through the lungs of a full-grown man, carrying nourishment and restoratives to every fiber and enabling it to rid itself of its morbid excretions. The rapidity of the remedial process has more than once forced upon me the thought, "What persistent outrages against the health laws of Nature must it have required to make the lungs the seat of a chronic disease!"

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* "It has been calculated by M. Rouchoux that as many as 17,790 air-cells are grouped around each terminal bronchus, and that their total number amounts to not less than 600,000,000" (Carpenter's "Physiology," p. 507).

The mountain-cure remedies assist Nature only in an indirect way, but before the end of the first week the BREATHING POWER of the asthmatic lungs will revive as seeing and hearing awaken after a trance. The respiration is still short and quick, but becomes less and less laborious; the patient need not gasp for air; his lungs have resumed business, and attend to all the details of its functions till it becomes entirely automatic.

EXPECTORATION becomes less frequent; the source of the affection seems to retreat upward, the *sputa* come from the upper air-passages, and without the preliminaries of a worrying cough. Their quantity gradually diminishes, and the relief is permanent, while cough-medicines loosen the phlegm only by increasing its quantum, and discharging it with a tide of artificial mucus.

The NIGHT-SWEATS, too, soon disappear, for they can be cured on the *similia similibus* principle of the homœopathists—by day-sweats. Put on a flannel shirt, get an old axe and try your luck with a good-sized bee-tree, or with the old log that obstructs the trail. Keep a tin cup about you, and assist Nature by frequent trips to the spring. No matter if you have to change your flannel shirts four times a day; depend upon it that you will not need them at night. The hectic fever abates; the cause has been removed. The sweats as well as the fever are induced by a pulmonary inflammation that increases the temperature of the body, but can be relieved by giving it a chance to eliminate the morbid matter. The four or five quarts of water that were excreted in the process of perspiration have circulated through every pore of the respiratory organs and depurated them more effectively in a single day than the repeated doses of a cough-exciting nostrum could do in a week. After the return from the mountains to the city (not before November, if possible) the occasional recurrence of the trouble will generally be limited to the rainy weeks of the first month, for the antipyretic influence of cold, clear weather rivals that of the perspiration-cure.

The danger of a HÆMORRHAGE is generally passed when the cessation of purulent expectorations proves that the disease has become non-progressive, and that the ulcers begin to cicatrize. *Hemoptysis*, or blood-vomiting, is the only symptom of their disease which is liable to shake the characteristic *hopefulness of consumptives*. It generally frightens them considerably; they are apt to protest against out-door proceedings, and speak with bated breath, under the (erroneous) impression that a vocal effort has somehow induced the trouble. It can do no harm to humor that disposition; but keep the patient on his legs—lying down flat on the back after a heavy hæmorrhage is almost sure to bring on a relapse before the end of twenty-four hours. For the first three or four hours walk slowly up and down, try to keep up a deep and calm respiration, and, if possible, take the first nap in a sitting posture—propped up with cushions and pillows. At the end of forty-eight hours the danger is past, and out-door exercise may be gradually resumed.

For stubborn DYSPNŒA (want of breath) there is a somewhat heroic but almost infallible palliative, though I own that the *rationale* of its efficacy is somewhat undefined—artificial insomnia. Read or write as long as that will keep you awake; after midnight walk up and down the room for fear of falling asleep in the chair, and toward morning, when drowsiness becomes irresistible, go to bed for a few hours, and that they will be passed in peaceful sleep can generally be inferred from the circumstance that by that time the dyspnœa has disappeared. After the second night's vigils the trouble is not apt to recur for a month or so. But, unless the distress is utterly unbearable, or the necessity for prompt recuperation very urgent, it is, on the whole, better to eschew palliatives and rely on the only permanent asthma-cure—the gradual but normal invigoration of the whole system.

In CHRONIC CATARRH—a frequent concomitant of a tubercular diathesis—the obstruction of the nasal ducts by accumulated mucus yields in a day or two to any exercise that brings into play the muscles of the neck, shoulders, and chest, such as shouldering a good-sized log, walking bolt-upright with two large pails full of water, or a loaded wheelbarrow. A very simple household remedy is a palliative to the same effect: hot water applied to the palms of the hands and the soles of the feet. It affords immediate though often only temporary relief; for the diathermal influence of the hot-water treatment, as it were, dries up, and thus temporarily reduces the mucous accumulations, while the preferable exercise-cure more gradually but permanently removes the cause of the trouble.

The stitch-like PAIN IN THE CHEST is apt to recur with every catarrh, and forms, indeed, only an incidental concomitant of tubercular consumption. It is a pleuritic affection, and is often entirely wanting in cases that end with death by tubercular cachexia. The Calmuck Tartars, who defile the air of their family tents with tobacco-smoke and suffer the usual consequences, cure pleuritic inflammation by a simple method of inunction: viz., by fomenting the nape and chest with hot mutton-tallow. When loss of appetite indicates a derangement of the digestive organs, ointments may be used as a temporary substitute for a demulcent diet.

Dropsical swellings, chronic diarrhœa, with frequent chills, prove that the disease has reached the colliquative or hopeless stage of its development. But, even under such circumstances, the mountain-cure, in the form of moderate exercise in the pure air of a highland sanitarium, will confer at least the negative benefit of saving the patient from the horrors preceding the last act of a hospital-tragedy—it will insure an anæsthetic conclusion of the disease; the vital strength will ebb away in a painless *deliquium*.

But while the vital forces still keep the foe at bay, i. e., before the symptoms of the decline have assumed the chronic form, before the process of digestion becomes utterly deranged, before the impoverishment of the blood results in dropsy and a livid discoloration of the lips, while the patient has intervals of sound sleep and sound appetite, and strength enough left to walk a couple of miles—there is more than an even chance that the disease can be permanently cured. One memento only of its ravages will remain—the acceleration of the breathing-process whenever the convalescent engages in active exercise. But even that inconvenience can be diminished by a system of training that will gradually inure the lungs to the strain of the ordinary movements and exertions of daily life: namely, by walking up-hill (or up-stairs) with a load of daily increasing weight. After two months or so it will take two scuttles full of coal to produce the panting and gasping which used to result from a small pailful of water, and the mere weight of the body will seem barely sufficient to indicate the difference between a rough mountain-trail and a graded pike-road.

A few years ago an emaciated Canadian miner came South for his health, and located a small placer-claim on the plateau of the "Fort Mountain," in Murray County, Georgia. The mountain is a mile high, and the up-trip with a few dozen eggs from the next valley farm obliged the miner to stop every few minutes to keep his chest from bursting, but before the end of the year he was able to make the same trip, without a stop, with a bushel-bag full of corn-meal. The waste from the corrosions of the tubercle-virus can perhaps never be repaired, but the healthy tissue of the remaining portion of the lung is susceptible both of expansion and invigoration. The lungs expand and contract with the chest. If three sisters marry on the same day—the first a ferryman, and learns to row a boat; the second a tailor, and takes to tight-lacing; the third a grocer, and tends his shop—an autopsy would show that in twenty years after their separation the ferrywoman's lungs have grown fifty per cent larger than the shopkeeper's, and fully twice as large as the dressmaker's.

But few consumptives ever outgrow the sensitiveness of their lungs, and must beware of contagion, avoid crowded meetings and lectures, and rather offend Mrs. Grundy than prolong their visits to a catarrh-infected house. Thoroughly healed though reduced lungs (reduced often to two thirds of their original size) will perform their functions in a sufficient manner for a long series of years. With the above-named precautions and a nutritive but strictly non-stimulating diet, there is no reason why a convalescent from pulmonary scrofula in its most unmistakable form should not enjoy an out-door festival in honor of his eightieth birthday. It is well known that in the *deliquium* of pulmonary consumption, in the stage of violent hæmorrhages and dropsical swellings, the confidence of the patient often gives way to gloomy forebodings—the harbingers of the long night that never fails to cast its shadows before. But this despondency is not more significant than the hopefulness that precedes it. For I believe that instinct is right in both cases, and that in the first stages of its development consumption is really the most curable of all chronic diseases. Chateaubriand, Heinrich Voss, Count Stolberg, Alfieri, Francis Deak, and Dr. Zimmermann, were descended from consumptive parents, but redeemed their constitutions by traveling and out-door exercise, and attained to a more than average longevity. Goethe, in his younger years, was subject to hectic fevers, with frequent hæmorrhages, but recovered and died as an octogenarian.

A tendency to emaciation, the most characteristic symptom of tuberculosis, generally continues to counteract the normal effects of a liberal diet, even combined with continence and a tranquil mode of life; but the limitation of that tendency is a sufficient guarantee that the disease has become non-progressive. But there is a still surer criterion: consumptives are generally remarkably fair and smooth skinned. The reason is, that the dross of the cachectic system gravitates toward the diseased lungs. An East-Indian surgeon found that small-pox can be localized by rubbing the chest with croton-oil, and thus concentrating the eruption. Pulmonary consumption is a kind of centralized scrofula. Two hundred years ago, when the cutaneous form of the disease was more frequent, surgery was often invoked to remove ulcers that threatened to disfigure the patient or destroy his eyesight. The approved method was to produce an artificial and larger sore, where it could not do so much harm, on the arm, below the chin, or on the nape of the neck. The larger sore attracted the morbific matter; and thus healed the smaller one. For cognate reasons, a scrofulous affection of the respiratory organs acts, as it were, as a *cosmetic*. Pimples disappear; boils head at once, and without suppuration; intemperance, surfeits, a congenital taint of scrofula, do not affect the color of the face; and (excepting the effect of gross dietetic abuses, which ultimately react on the lungs) the cutaneous excretion of such impurities is therefore not an unfavorable symptom. For their reappearance on the surface of the body proves that the respiratory organs have ceased to attract the cachectic humors of the system; in other words, that the tubercle-sores have cicatrized, and the lung-destroying virus has been eradicated.

A GERMAN VIEW OF THE "DATA OF ETHICS." *

By FRIEDRICH VON BAERENBACH.

PHILOSOPHICAL thought is tending more and more toward concentrating itself upon problems of physiological as distinguished from metaphysical psychology, and to the inquiry after those facts which can be ascertained. The best workers in this field are still troubled, nevertheless, lest they may lose the connection with the sciences, and particularly with that special research and exact calculation under the influence of which a happy reaction has made itself felt in the various departments of philosophy against the intuitive and undisciplined ways of thinking that have characterized many metaphysicians.

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* Translated and abridged for "The Popular Science Monthly" by Thomas Cross.

As in life all gives place to the question of the highest utility, so in science all gives place to pure theoretical interest in enriching our knowledge of facts. But, while this may find its justification in the history of culture, the problems of the work of culture are no more exhausted thereby than the problems of thought. Philosophy would surrender her most important function were she to shirk the solution of those problems which she alone can solve. To these problems belong, last not least, those of ethics.

The progress of scientific knowledge in all domains of inquiry is the mightiest instrument in aid of the progress of culture. Its influence reaches, directly or indirectly, to all human relations, not excepting moral development. Apparent contradictions diminish or disappear before the macroscopic glance, which, not fixed upon any isolated point, takes in the whole range of facts and causes in their mutual relations. We are at the same time convinced, even by the consideration of the educational influence which scientific efforts have acquired in all strata of modern society, that all is not done. The gap is visible and sensible in philosophy and in life.

The needs of a great community of thinking men neither seek nor find any satisfaction in the dogmas of a positive confession of faith, while, for the foundation of a system of practical regulative laws and ethical principles, the progress of inductive science does not furnish all that is needed. A bridge is wanted, which shall establish connection with active life; a well-spring of right, from which laws and principles can be drawn and distributed.

According to some philosophers, ethics stands or falls with metaphysics. That this is not the case has been proved by the isolated achievements in moral philosophy of the disciples of modern positivism, and is demonstrated afresh by Herbert Spencer in his "Data of Ethics." This author occupies so conspicuous a position among the philosophic writers of the century, that the summons to a study of his works may well find ample response.

We may gather, from the preface to his last work, how Herbert Spencer, like other founders of great philosophic systems, esteems the importance of ethics. "This last part of the task it is to which I regard all the preceding parts as subsidiary." From the beginning of his philosophical activity this was the "last goal," the object to which all efforts were preparatory—to find a scientific basis for the principles of good and bad in action.

"Now that moral injunctions are losing the authority given by their supposed sacred origin, the secularization of morals is becoming imperative. Few things can happen more disastrous than the decay and death of a regulative system no longer fit, before another and better regulative system has grown up to replace it." For this reason, Herbert Spencer has sought to fill the gap caused by the disappearance of the code of supernatural ethics, by a code of natural ethics.

The vacuum is before us, while some consider the filling of it superfluous and others impossible. Herbert Spencer believes that it can and must be filled. High above all problems of cultural and scientific endeavor he places that of the foundation of scientific ethics.

It is presumed, in the conception of ethics, that it shall establish the "ought." Unlike other moral systems, scientific ethics deals with the establishment of the practicable "ought"; not with duties *in abstracto*, but with duties which can be performed. For, "by association with rules which can not be obeyed, rules that can be obeyed lose their authority." Here the critical point of view is established whence scientific ethics must prove the conclusions of moral philosophers upon their merits.

Throughout the "Synthetic Philosophy," which will be closed by the "Principles of Ethics," of which the "Data of Ethics" forms the first part, the fundamental principles of modern evolution are enlisted for the solution of biological, sociological, and psychological questions, to such an extent that this philosophy may be described as a distinct branch of the philosophy of evolution. No system of natural philosophy has, with equal consecutiveness and completeness, adapted the achievements and the hypotheses of modern natural science to the construction of a philosophy on a scientific foundation.

Herbert Spencer's "First Principles" serve as an introduction to this philosophy, and define the stand-point from which the author surveys the whole range of philosophical inquiry. This work undertakes the experiment of a universal application of the fundamental laws and hypotheses of natural science, at the same time generalizing the principle of evolution, and making it the one great underlying principle. It takes up the work of critical philosophy, defining the limits of the knowable and the unknowable. It attempts the only possible reconciliation between religion and science, by pointing to their common, final resting-place in the absolute. The works included in the "Synthetic Philosophy" form parts of a great system held together by the principle of evolution; displaying stupendous learning, and a rare universality of scientific culture, entitling their author to a place, *mutatis mutandis*, beside Aristotle himself. These comprehensive writings afford, even to those who can not accept their underlying principles, a plenitude of instruction.

As to the statement of the problem in general form, serious difference of opinion is hardly possible. For every school and from every stand-point, ethics is a regulative discipline; not laws of the actual, but laws of the "ought"; not laws of conduct in general, but of conduct of a certain kind. As logic establishes the regulative laws and postulates of scientific knowledge, ethics establishes the regulative principles of moral life.

The stand-point assumed by the author, in dealing with evolution, serves also in ethics. It appears to him evident that, from indifferent actions to actions which are good or bad, the transition is quite gradual. In ethics, as in evolution, the higher development must be explained by the lower. The study of ethical problems presupposes the study of human action as a whole, and this again presupposes that of the actions of living beings in general. The study of the evolution of action forms the preparation for ethics.

It is shown, in the first place, that "higher organic development is accompanied by more highly developed action." The latter is "an improving adjustment of actions to ends, such as furthers the prolongation of life, such as furthers an increased amount of life." Action adapts itself more and more to self and race maintenance; and here also the general evolutionary principle is applicable. "Race-maintaining conduct, like self-maintaining conduct, arises gradually out of that which can not be called conduct; adjusted actions are preceded by unadjusted ones."

In treating of good and bad conduct, Herbert Spencer, in the first place, endeavors to establish the meaning of the terms "good" and "bad." Actions properly adapted to ends are good, and actions not so adapted are evil, both these definitions being taken in a relative sense only. Good conduct is identical with the most highly developed conduct, which "simultaneously achieves the greatest totality of life in self, in offspring, and in our fellow-men."

Pessimistic verdicts upon the value of life are combated by the author with all the might of his intellect, as standing in harsh contradiction to every paragraph of the unwritten moral code of humanity. He leans toward a limited optimism. He rightly urges that pessimists and optimists agree on one point. Both "assume it to be self-evident that life is good or bad according as it does, or does not, bring a surplus of agreeable feeling. . . . Each makes the kind of sentiency which accompanies life the test."

A general consideration of the conflicting views of life brings the author to the conclusion that the good, on the whole, is that which causes pleasure; that our ideas of good and evil arise from the certainty or probability that the same will call forth, somewhere or some time, pleasure or suffering.

Not man as an individual, independent of social relations, of family, people, state, society; not man or humanity in the abstract; but man in society, the social individual, the member of the social union, is the subject for whose moral action, for the adaptations of whose conduct to the highest aims of social life, it is the business of scientific ethics to establish normal principles. It was, therefore, necessary to loosen the bonds which had bound ethics to unscientific propositions and dogmas of traditional transcendentalism, and to establish its scientific character by a union with the foundations of our scientific knowledge. This, in brief, is the programme for the reform of ethics, or, rather, for its establishment on a new basis. The unscientific methods employed by ethical writers are sharply criticised; the logical propositions upon which the foundation of scientific ethics depends are clearly stated; and the false premises exposed which render all scientific procedure impossible.

In the exposition of the relativity of suffering and enjoyment, and in the sections on "Egoism *versus* Altruism" and "Altruism *versus* Egoism," the author grapples with the fundamental problems of anthropological ethics. The priority of egoism is convincingly set forth, the spontaneous origin of pure altruism, and the interdependence and complementary relations of both principles; while the one-sided assertions and demands of their respective champions are refuted. The final reconciliation of egoism and altruism is inferred from evolution, from which the author also reaches that conciliatory and compromising position which enables him to reconcile many seemingly contradictory phenomena.

Evolutionary morals are wholly hedonistic. The happiness-giving is the good; and it is owing to theological and political influences alone that mankind overlook this truth. The idea and the desire of happiness, of perfect well-being, necessarily mark the character of good conduct. Moral life is a series of compromises between egoism and altruism. All other moral principles derive their conditional justification from this first principle of human action, which is characterized by Kant as the negation of all morality. The idea of perfectibility is tried by the same standard, and we are reminded that capacity for the reception of happiness is the highest proof of the perfectibility of human nature. Aristotle, who recognized happiness as the highest aim of human endeavor, took a step out of his way when he "sought to define happiness by the aid of the word 'virtue,' instead of defining virtue by the aid of the word 'happiness.'" Hence it must be conceded that "the conception of virtue can not be separated from the conception of happiness-producing conduct; and that, as this holds of all the virtues, however otherwise unlike, it is from their conduciveness to happiness that they come to be classed as virtues."

The welfare of society as a whole is regarded as the first problem, but not as the final object, being preparatory to the furthering of individual life and welfare, which is to be compassed by the fostering of social interests. The subjection of personal to social welfare is regarded as a temporary consequence of the existence of antagonistic societies; and, when the social aggregate, arrived at a certain elevation of development, shall no longer be in danger, the welfare of individuals will be the object. Individual happiness has the last word.

In the "System of Synthetic Philosophy," evolution is the universal world-law, the law of laws, dispensing with all need of stern commandments of revealed religion and theological morality. The evolution of human nature and society brings with itself this, that human conduct becomes better and better adapted to individual and social aims; that good conduct (adapted to the preservation of the race) gradually overpowers bad conduct (unadapted to self and race maintenance) in that struggle for existence in which morality and virtue have on their side every advantage. As the fitter organism survives the less fit, so must moral conduct in the natural course of things gain the upper hand, and immoral conduct tend more and more toward extinction. Thus, according to immutable laws, higher forms of conduct must be evolved from the original conduct of man in his lower estate, as higher organisms are evolved from lower. Changes such as have taken place in the course of civilization will take place again. The want of faith in a further like development, whereby man's nature will be brought into harmony with his condition, is only one of the innumerable proofs of an inadequate knowledge of causality; and he who has learned to put aside primitive dogmas and primitive ways of looking at things, and who has appropriated those modes of thought which science produces, can not believe that the "wholesome working Force" which has hitherto so changed all forms of life according to the altered requirements of their being, will not continue to operate in the same direction.

Ethical evolution affords an imposing outlook for the future of mankind. Man does not waver, like Hercules, between virtue and happiness. He is spared all pain of choice. Virtue and happiness are the one inseparable goal which he approaches with steady advance. Nature herself leads him on, and he has in his own nature the assurance of victory. Ceaselessly bent upon his own advancement, restlessly at work improving the conditions of his existence, he at the same time nourishes his moral life. No moral law opposes the impulses to this advance. No antinomy between moral and natural law needs solution, no strife between moral and sensual impulses need be decided. Always and everywhere an aspiration, a goal. No subjection of the *ego* to a law which commands without regard to weal or woe, no sacrifice of individual claims, no giving up of self at the bidding of an absolute moral law. Development is never interrupted. In ceaseless progress it approaches the goal—the greatest sum of well-being. The rigoristic "Thou canst, for thou oughtst," has no place here. Guidance is enough, compulsion is not needed.

This ethics is confessedly utilitarian, before all things a higher form of utilitarianism; but no raw materialist philosophy of usefulness, addressing itself to brutal egoism, to sensual enjoyment, to the worship of material wealth, to the thirst for riches and power at the expense of others. Whatever furthers development and brings its goal nearer, is useful; and the goal of development lies in a fair and distant future, whose outline the philosopher thinks he sees. The highest aim, to which all others are subsidiary, to which the strivings of the best are directed, is a moral order of life corresponding to the noblest longings of reason, of the most highly developed man in the most highly developed society. Such a system appeals to that ennobled and enlightened utilitarianism which constitutes the longing after ideal possessions—the condition of the highest welfare of man.

The rigorism of other moral systems has no place in the ethics of evolution. Its moral law is not like that of Kant, sublimely above all connection with natural impulses and inclinations, nor does it constitute moral life a continuous battle against desires which aim at the furthering of individual happiness. "Great mischief has been done by the repellent aspect habitually given to moral rule by its expositors, and immense benefits are to be anticipated from presenting moral rule under that attractive aspect which it has when undistorted by superstition and asceticism. If a father, sternly enforcing numerous commands, some needful and some needless, adds to his severe control a behavior wholly unsympathetic; if his children have to take their pleasure by stealth, or, when timidly looking up from their play, ever meet a cold glance, or more frequently a frown—his government will inevitably be disliked, if not hated; and the aim will be to evade it as much as possible. Contrariwise, a father who, equally firm in maintaining restraints needful for the well-being of his children or the well-being of other persons, not only avoids needless restraints, but, giving his sanction to all legitimate gratifications and providing the means for them, looks on at their gambols with an approving smile, can scarcely fail to gain an influence which, no less efficient for the time being, will also be permanently efficient. The controls of two such fathers symbolize the controls of morality as it is and morality as it should be."

This comparison, however, does not hold good of all forms of rigorism. Kant's moral law knows neither inclination nor disinclination. It neither attracts by rewards nor terrifies by punishments. It is neither the father who adds unsympathetic bearing to stern supervision, nor the father who helps the enjoyment of his children and watches their games. It is sublime above all traffic with the inclinations. And it may still be asked whether Kant was "so far from the track of truth" when he sought the ethical criterion in the law-abiding, duty-abiding sentiment, and maintained the supremacy of that sentiment with that enthusiasm which inspired his famous apostrophe to duty: "Duty, thou sublime, thou lofty name; which embracest within thee naught beloved bringing flattery; commanding submission, though threatening nothing to move the will, but only setting up a law which of itself finds entry into the breast, and wins for itself unwilling reverence, if not always obedience; before which all desires are dumb, even should they work against it in secret. What origin is worthy of thee, and where shall I seek the roots of thy noble descent, which proudly spurns all kinship with the desires?"

But, if we accept the system of Herbert Spencer, the rigoristic conception of Kant appears superfluous and even injurious. The doctrine of natural development affords a glimpse of the promised land, of a future wherein virtue and happiness will mean the same thing, wherein no antagonism will be conceivable between duty and inclination. No ethics can cheer us to unresting strife by a nobler goal, none can hold out a sublimer prospect. A beautiful faith is that in the upward movement of humanity. It renders easy the battles, the dangers, the countless sacrifices, which lie in the way.

But, notwithstanding the merits of the work under consideration, in certain principal utterances, and in its distinguished contributions to relative ethics, the fundamental principle of absolute ethics, the ethical criterion of action, appears to belong as yet to the number of those problems most needing solution. The last word is not yet spoken; but the results placed in our possession so far, justify the assumption that the evolutionary system of Herbert Spencer will materially assist the thorough reform of ethics, by its critical and positive preparatory work.

COST OF LIFE.[*]

By JOHN PRATT.

NOTHING so forcibly strikes the attentive observer of natural phenomena as the prodigal expenditure of force and matter—the immense over-supply of seed; the enormous waste of sun-force in irrigation; the incalculable power, never to be utilized, represented in tidal action, and in atmospheric, oceanic, and river currents. If we extend our observation to the solar system and the inconceivable spaces intervening between that and the neighboring systems, the imagination fails to grasp the relation between the force that is utilized and that which is wasted. A million carried to the tenth power as a multiple, would fail to represent the waste of natural forces, as compared with the rudest Newcomen pumping-engine of the earliest type. This is familiar science, yet the expansion of the idea may present some points of novelty.

It is obvious that the whole system of planets, representing so many minute points in space, receive only an almost infinitesimally small proportion of the light and heat evolved by the sun. Some physicists are fond of giving the exact figures, but this is presenting the inconceivable. Siemens has made a very unsatisfactory effort to show that the force is conserved. He has made but few converts to his theory. It is the purpose of this monograph merely to expand the received idea of waste, by showing that the recipients of the prodigal bounty of the great giver of all good in our solar system—the sun—are far fewer than is usually supposed.

Before the spectroscope taught us that the reign of chemism is co-extensive with that of physics, many conjectures were indulged in by astronomers as to the inhabitability of the planets in general. It was taken for granted that there was probably an endless variety in the forms, composition, and even original substance of matter. Vegetation and animalism probably assumed wonderful shapes, and were capable of existing amid conditions not only altogether different from the terrestrial, but altogether incompatible with life on this earth. This conception, unphilosophical *a priori*, and indirectly the fruit of the wonder-instinct and that bias inherited, according to Comte, from the theological *régime*, has been swept away, and the reign of law extended to the mystic dream-lands of the universe. No thinker so loosely hinged now as to imagine life without a certain degree of heat, light, and without oxygen, hydrogen, carbon, and all the chemical elements, and that too in protean forms. Nay, more, the forms and succession of life must be, wherever found, substantially such as we are familiar with. If Venus has human inhabitants, they are not one-eyed Cyclops, nor does vegetation bury its leaves in the ground and spread its roots in the air. Organs, and functions, and instinct are there also, subject to the grand laws of selection and development. Further, the absence of conditions essential to the sustenance of life on our globe would be equally fatal in any other. This brings up the question in hand—the scarcity, as a part of the problem of the cost, of life.

What planets are inhabited? Let us begin with the giant worlds on the verge of the system. In the first place, as might have been conjectured even before the revelations of the spectroscope, from their great volume of light as compared with their distances from the sun, all of these great bodies are self-luminous. They are at least incandescent, and doubtless Jupiter and Saturn are in a fluid, perhaps gaseous state. There can not be the slightest doubt that they are no more fit for life than the sun itself. Will they ever become the habitations of living things? Ignoring their distance from the sun, which to an inhabitant of Saturn would have about the apparent magnitude that Jupiter has to us, there are other considerations which set that question at rest.

The volume of Jupiter, for example, is about 1,280, Saturn 991, Uranus 80, times that of the Earth. The density of Jupiter being about 1·40 and that of the Earth 5·48, it follows that the attraction exerted by Jupiter is, roughly, 300 times that of the Earth. A man who weighs 150 pounds on the Earth, if transported to Jupiter, would shake the ground with a ponderous tread of 45,000 pounds, or 22½ tons! His own weight would at once crush him into a mere pulp. A hickory-nut, falling from a bough, would crash through him like a Minié-ball. Again, water would weigh fifteen times as much as quicksilver. A moderate wave would shiver to atoms the strongest iron-clad, a rivulet would quickly form cañons miles deep, and ordinary hailstones would destroy every living thing. If we suppose the existence of an atmosphere, even no more profound than our own, its weight would be a third that of water, and its pressure 4,500 pounds to the square inch—sufficient to crush a rhinoceros or the boiler of a steam-engine. In motion, as a moderate breeze, it would sweep away not only every work of man, but the very hills and mountains. The same condition, in less degree, may be predicated of the lesser of the giant planets, and Jupiter is only selected as the most striking example.

Putting aside the hundreds of known, and the thousands and millions of unknown asteroids, as obviously unfit for life, let us next consider the case of Mars. The relative mass of Mars being only about $\frac{1}{60}$ that of the Earth, it follows, as a necessary consequence of the laws of gravitation, that our typical man would only weigh about 2½ pounds on the surface of that planet. Individual locomotion would be wonderfully facilitated, but its conditions would be reversed. The familiar dream of flying by a mere upward movement of the limbs might easily be realized in Mars, but an 80-ton locomotive would not propel a train of empty cars, and mechanical work of all kinds would be practically impossible. Niagara Falls, in such a planet, with water approximating the weight of air, would scarcely furnish power for a mill. A rifle-ball might be caught in the hand without harm. It is obvious that, with an atmosphere of the density of our own, animal and vegetable life, and every artificial work, representing so many structures of gossamer, would disappear like magic at the first breeze. But no such atmosphere as ours is possible with Mars. Even supposing it to equal our own in altitude, its pressure would be only about one fourth of a pound to the inch. Life is impossible in such an atmosphere, as is shown by a far less tenuity at the summits of lofty mountains. But, even if gravitation were not deficient, the distance of Mars from the sun entitles him to considerably less than half our supply of light and heat; a disadvantage immensely aggravated by his very eccentric orbit. Croll has shown how the shifting eccentricity of the earth's orbit, by adding three weeks to the duration of winter, brought about the glacial epochs, and covered nearly the whole earth with ice at various eras. Conceive, then, the thermometer in the Martial torrid regions touching 50°, and that even under the hypothesis, rendered impossible by the very laws of gravitation, of an atmosphere as dense as our own! Nothing can be more certain than that there is no liquid in Mars, and no life.

The same set of conditions, in exaggerated degree, exist in the minor superior planets, Ceres, Pallas, Juno, etc., while the asteroids are as much out of the question as the comets and meteors. In regard to the Jovian and Saturnian satellites, only probable conjecture can be indulged. We do not know with sufficient accuracy the degree of heat and light received from their primaries, to judge of those conditions, but all the obstacles flowing out of deficient gravitation predicated of Mars exist in equal degree in these satellites, the largest of which is inferior to Mars in dimensions.

In regard to our own moon much more definite information is accessible, though little need be said of its present life-conditions. Its bi-monthly axial revolution, its long, more than torrid day and antarctic night render it unnecessary to consider the question. But the mass of this satellite being about a third less than even that of Mars, interposes, and has ever interposed, the same everlasting mechanical obstacles to life there as in Mars. Atmosphere the moon may once have possessed, but it must always have been insufficient for life, insufficient to secure the stability of water, which, even if it continued in a liquid condition, would be swept—so light was it—in vast tides over the highest mountains. For the rest, if there be a man in the moon, it is interesting to know that he weighs less than two pounds, and can jump a mile, more or less.

Mercury, with a temperature of boiling water in the frigid zones and red-hot iron at the equator, may be a good place for a Calvinist to send his wicked neighbor, in imagination, but it can not be placed among the list of inhabited worlds. At last, then, out of all the vast, the countless myriads of circling orbs that do homage to our sun, only two remain to be considered—the Earth and Venus.

Venus, although too near the sun to render it likely that her tropical regions are habitable by man, is, so far as can be judged from her general physical condition, by no means destitute of life. If there be truth in the nebular hypothesis, Venus is younger than the Earth, and is therefore perhaps not evolutionized as to the highest forms. As to this, speculation would be little better than conjecture. Enough, that of Venus it can not be said, as of the other planets, with a certitude derived from the exact sciences, that there is no life in her.

The insignificant little globe called the Earth furnishes the only assurance of the higher forms of life, and, with the one exception of a globe even less than ours, of life in any stage of evolution. The Earth is not the millionth part of the known matter of our system, and, compared with the space occupied by that system, is far more insignificant than the smallest fleck of foam in the ocean. This tiny island in space does indeed teem with life; but, if this life were distributed equally through the space given to its production, thousands of miles would intervene between every individual form.

So much for the space and energy expended in the evolution of vitality. The same immense expenditure, the same apparent disproportion discloses itself when we consider the time that has been consumed in the process. Here we are again confronted by figures approximating eternity. Life has existed on the Earth millions of years, and mammalian life hundreds of thousands of years. Yet such periods are insignificant in comparison with the cosmogony of the planets. The duration of the highest order of life, under the refined conditions of a high type of civilization, is but of yesterday comparatively, but it has taken so enormous a period to ripen that we can no more conceive of it than of eternity. A space so vast that it is a tedious journey for light to traverse, and a lapse of time so great that a snail might have made the circuit with ease in the morning of it, have been necessary to give birth to one Shakespeare! All this space, and all this time, and all this immortal energy have as yet barely sufficed to develop a few organisms capable of a glimmering comprehension of the forces which have evolved them. All the rest, if the accepted theories of gravitation and light and heat are not wholly illusory or misunderstood, is waste space, waste matter, waste energy. Life is far more rare and far more costly in our solar system than diamonds in the earth.

But why not? Space is boundless, matter is infinite in quantity, and time is limitless, past and to come. Where the treasure is exhaustless, the question of cost is only interesting from a speculative point of view. This as regards the past.

One of the elements of cost—time—has an interesting bearing on the future of the universe. Some scientists have of late indulged in presages more despondent than philosophical. According to this school, the dissipation of energy into space will finally result in the death of matter. Matter, being indestructible, will exist forever, but its soul will perish; first the vital form, then electricity, light, and heat, and finally even atomic vibration—leaving all cosmic bodies mere cadavers, like the terrestrial moon. This view has been combated by special theories, like that of Siemens, but not with great success. But there is a large aspect of the question which, though it seems to have escaped the attention of thinkers, at once sets it at rest, and demonstrates that energy and life are immortal. Bacon says of eternal duration, that, dividing it into past and future, it is of no consequence where we draw the line; a billion years ago, or a billion years hence, or the present, the two parts are still equal to each other and to the whole; thus contradicting all the laws of quantity. If this be a paradox, it has the peculiarity of being irrefutable, since it is impossible to conceive of any greater eternity than either the past or the future. Assuredly it can not be maintained that the future eternity is greater than the past. Assuming, then, this postulate, and that energy in all phases has been eternal in the past, it follows, with a force that commands unhesitating assent, that it will be eternal in the future. Whatever is, has been; whatever will be, has been. Energy has had one eternity in which to dissipate itself. What one eternity has not sufficed to bring about, will never be consummated. It may be interesting, but it is not essential to the demonstration, to investigate the method by which energy dissipated becomes once more potential. Perhaps the most tenable theory is, that it will be accomplished by the collision of dead worlds with each other, and the resulting mechanical evolution of light and heat. According to this view, attraction is the grand reservoir of the generic energy of the universe, on which all matter may draw when its differentiated force has been dissipated. But, be this as it may, the fruitful union of matter and energy in the infinite past is a stable guarantee that they will never be divorced.

ON SCIENCE-TEACHING IN THE PUBLIC SCHOOLS.*

THE repeated appointment, by this body, in successive years, of committees to look into the scientific education of the public schools, must be taken as showing that such an inquiry is regarded as both legitimate and important. Yet the duties of such a committee have not been defined by the Association, nor have any of our predecessors opened the way to a consideration of the subject. It was probably expected that we would furnish a digest of information from many quarters, as to what sciences are taught in the public schools, with what facilities, and to what extent; accompanied by such recommendations regarding the increase of scientific studies as the results might suggest. But our course has not proved to be so clear. We have been arrested at the outset by a question of the quality of the science-teaching in these schools which demands the first consideration. There are certain radical deficiencies in current science-teaching, the nature and extent of which must be understood before any measures of practical improvement can be intelligently taken up. We shall here confine ourselves to this preliminary inquiry.

The investigation has interest from the immense extent and rapidly increasing influence of the American public schools. There are now nearly a hundred and fifty thousand of these schools, supported at an annual expense of probably seventy or eighty million dollars. Maintained by State authority, they are firmly established in the respect and confidence of the community. Under the influence of normal schools, teachers' institutes, systematic superintendence, school boards, regulative legislation, and an extensive literature devoted specially to education, they have become organized into a system which is gradually growing settled and unified in its methods. With unbounded means and unlimited authority, these schools have undertaken to form the mental habits of the great mass of the youth of this country. They prescribe the subjects of study, the modes of study, and the extent and duration of studies for all the pupils that come under their charge. The sphere of their operations is, moreover, steadily extending. They are everywhere encroaching upon the province of higher education, everywhere trenching upon private schools, and diminishing the interest in home education.

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* Preliminary report of the committee, appointed at the Saratoga meeting of the American Association for the Advancement of Science, on "Science-Teaching in the Public Schools," read at the Boston meeting, in August, 1880, and published in the "Transactions" of the Association.

It may be assumed that the time has fully come when this system must be measured by the standards of science, and approved or condemned by the degree of its conformity to what these standards require. Science has become in modern times the great agency of human amelioration, the triumphs of which are seen on every hand and felt in all experience. Grave subjects are brought successively under its renovating and reconstructive influence; and latest and most important among them is the subject of education. Our inquiry now is how far the public-school system has availed itself of the valuable aid that science offers in the proper cultivation of the minds of the young.

The interest and necessity of such an investigation will hardly be denied; but there may be a query as to its relevancy to the appropriate work of this society. The making of science popular was not among the objects for which our Association was formed. Not that its founders were unmindful of the importance of widely diffusing the results of research; but they recognized that the interests of science are so vast as to be only efficiently promoted by division of labor. Under the operation of this principle it was made the distinctive purpose of the Association to contribute to the extension of original science by the discovery of new scientific truth, leaving its dissemination to the schools, the press, and the various agencies of public enlightenment. Nor does your committee understand that it is now proposed to depart from this policy; for the inquiry before us is really most pertinent to our special objects. It certainly can not be a matter of indifference to this body, from its own point of view, how science is dealt with in the great system of schools which has undertaken the task of molding the youthful mind of the country. We aim to advance science by the promotion of original investigation, which depends upon men prepared for the work. Do the schools of the nation, by their modes of scientific study, favor or hinder this object? Do they foster the early mental tendencies that lead to original thought; or do they thwart and repress them? We have an undoubted concern in this matter, and it is, moreover, strictly identical with that of the community at large; for there can be no better test than this of the real character of the school system. When we ask whether a mode of teaching and a manner of study are calculated to awaken the spirit of inquiry, to cultivate the habit of investigation, and rouse independent thought, our question goes to the root of all true education.

All sciences are the products of a method of thinking, and it is that method which concerns us when we propose to regard it as a means of mental cultivation. Science is an outgrowth of common knowledge, and the scientific method is but a development of the ordinary processes of thought that are employed by everybody. The common knowledge of people is imperfect because their observations are vague and loose, their reasoning hasty and careless, their minds warped by prejudice and deadened by credulity, and because they find it easier to invent fanciful explanations of things than to discover the real ones. For thousands of years the knowledge of nature was rude and stationary because the habits of thought were so defective. But, with a growing desire to understand how the world around is constituted, men improved their processes of thinking. They began, and were compelled to begin, by questioning accepted facts, and doubting current theories. The first step was one of self-assertion, implying that degree of mental independence which led men to think for themselves. They learned to make their own observations and to trust them against authority. It was found, as a first and indispensable condition of gaining clear ideas, that the mind must be occupied directly with the subject to be investigated. In this way scientific inquiry at length grew into a method of forming judgments which was characterized by the most vigilant and disciplined precautions against error. Of the mental processes involved in research it is unnecessary here to speak; we are only concerned to know that the scientific method is simply a systematic exercise in truth-seeking, and is the only mode of using the human mind when it is desired to attain the most accurate and perfect form of knowledge. The whole body of modern scientific truth, disclosing the order of Nature and guiding the development of civilization, must be taken as an attestation of the validity of the scientific method of thought by which these results have been established. We here get rid of all cramping limitations. The scientific method is applicable to all subjects whatever that involve constancy of relations, causes and effects, and conform to the operation of law. It is applicable wherever evidence is to be weighed, error got rid of, facts determined, and principles established. Our public schools, unhappily, make but little use of this method in the work of mental cultivation, and we shall find some explanation of this by referring to the way they grew up.

The American public-school system originated in the theory that the State owes to every child the rudiments of a common education, or an elementary knowledge of reading, writing, and arithmetic, as implements of after mental improvement. But it was early found difficult to separate this primary use of tools from the acquisition of knowledge.

Mr. Everett said, "I will thank any person to show why it is expedient and beneficial in the community to make public provision for teaching the elements of learning, and not expedient or beneficial to make similar provision to aid the learner's progress toward the mastery of the most difficult branches of science and the choicest refinements of literature." Under the influence of such considerations the rudimentary studies rapidly developed into courses of study embracing a variety of subjects. This led to the systematizing of instruction and the grading of schools, so that in nearly all the towns of the United States the public schools have been divided into primaries for the younger pupils and grammar-schools for older pupils; while within twenty-five years a third grade has arisen known as the high-schools for the most advanced students. In each division there are sub-grades, and, wherever improvements in public-school education are attempted, the principle of gradation is fundamental. So essential is it considered, that no aid is granted from the Peabody fund except to graded schools. As regards the plan of studies adopted, there was no guiding principle. All sorts of subjects, and these for all sorts of reasons, were taken up, and among them the sciences which are now regular parts of public-school study. Classes are formed in physics, chemistry, mineralogy, geology, physiology, botany, and zoölogy. There are text-books upon all these branches, graded to the varying capacities of learners. Teachers prepare in them, and in many cases apparatus is provided, and there are lectures with experiments, specimens, maps, and charts for illustrations.

The old ideal of a school is a place where knowledge is got from books by the help of teachers, and our public-school system grew up in conformity with this ideal. The early effect of grading was to fix and consolidate imperfect methods. The sciences were assimilated to the old practice, and the science-teaching falls short at just the points where it was inevitable that it should fall short. The methods of school-teaching, and the habits of the teachers, had grown rigid under the *régime* of book-studies. As a consequence the science-teaching in the public schools is generally carried on by *instruction*. Through books and teachers the pupil is filled up with information in regard to science. Its facts and principles are explained as far as possible, and then left in the memory with his other school acquisitions. He learns the sciences much as he learns geography and history. Only in a few exceptional schools is he put to any direct mental work upon the subject-matter of science, or taught to think for himself.

As thus treated the sciences have but little value in education. They fall below other studies as means of mental cultivation. Arithmetic rouses mental reaction. The rational study of language, by analytical and constructive tasks and the mastery of principles, strengthens the mental processes; but the sciences are not employed to train the faculties in the various ways to which they are severally adapted. They are not made the means of cultivating the observing powers, stimulating inquiry, exercising the judgment in weighing evidence, nor of forming original and independent habits of thought. The pupil does not know the subjects he professes to study by actual acquaintance with the facts, and he therefore becomes a mere passive accumulator of second-hand statements. But it is the first requirement of the scientific method, alike in education and in research, that the mind shall exercise its activity directly upon the subject-matter of study. Otherwise scientific knowledge is an illusion and a cheat. As science is commonly pursued in book descriptions, the learners can not even identify the things they read about. As remarked by Agassiz, "The pupil studies Nature in the school-room, and when he goes out-of-doors he can not find her." This mode of teaching science, which is by no means confined to the public schools, has been condemned in the most unsparing manner by all eminent scientific men as a "deception," a "fraud," an "outrage upon the minds of the young," and "an imposture in education."

Nor has this criticism of bad practices been without its effect. We are met by the statement that much has been done in the public schools to escape the evils of mere book-science. The method of object-lessons has been extensively introduced into primary schools with the professed purpose of cultivating the powers of observation in childhood. It is claimed that this is a beginning in science; and, as it brings the mind into action upon things, is a corrective of the inordinate study of words. But object-teaching has not yielded what was expected of it, and is in no true sense a first step in science. Nothing is gained educationally by barely having an object in hand when it is talked about. Myriads of objects are present to the senses of people, but no insight follows. The observing faculties must be tasked if they are to be trained. The pupil is not to have the properties of objects pointed out, but he is to find them out. Science will do its work of educating the observing faculties only as they are quickened and sharpened by exercise in discrimination. The scientific aim is to replace vague confused impressions by clear and accurate ideas. Skill in the detection of nice distinctions is only gained by prolonged and careful practice. Object-lessons afford no such cultivation. We do not say that they are useless, but they are not the A B C of science, and do not as a matter of fact open the way to the proper study of the special sciences. This is their test and their condemnation. When the primary pupils have gone over their prescribed course of object-lessons and are passed on to a higher grade, strange to say the "objects" are suddenly dropped as if the objective method had been exhausted. In the technical phrase *perceptive* education is to be replaced by *conceptive* education. Instruction in elementary science is now to be carried on by what is known as oral-teaching. This method, as extensively practiced in the grammar grades of the public schools, is everywhere growing in favor, and we are once more told that it is a successful revolt against book-studies. It is chiefly applicable to the sciences, and its cardinal idea is instruction without a text-book. This looks fair, but it is delusive. The method does not remove the book that the pupil may come at the phenomena, but it removes the book that the teacher may take its place. Oral-teaching is class-instruction, in which information is imparted in a familiar manner with the view of awakening the interest of the class. But, so far as real science is concerned, it is doubtful if this method is not worse than the one it replaces. Following the maxim of certain German educators, that "the teacher is the school," it was assumed that when apathy prevails in the schoolroom it is solely the teachers' fault. Oral exercises enable them to escape this reproach by giving animation to school-work. It is said that this is a "live system" in contrast to the old humdrum routine of lessons and recitations. But science gets no real help. There is only the substitution of a superficial class-activity for the more deliberate work of the individual pupil. More mental effort is required on his part to get a lesson from a book than to listen to a lesson given by the teacher. The teacher is to do everything, and stands in the place not only of the book but of the pupil also. Is this not a step backward in education? The teacher is magnified at the expense of close study, and science is cheapened by the method. Oral-teaching implies a fertility, a versatility, and a proficiency in scientific knowledge on the part of teachers which that class of persons does not possess. It is a premium on tutorial smattering and cramming by which the voluble teacher with superficial acquisitions and a ready memory becomes the model teacher. There may be benefits in this method, but science does not gain them. Judicious oral assistance, as in the physical, chemical, or natural history laboratory, given by a competent master to a pupil at work, is invaluable for stimulus and guidance; but the aid must be discreet, and the skillful teacher will not talk too much. But where it is all talk and no work, and text-books are filtered through the very imperfect medium of the ordinary teacher's mind, and the pupil has nothing to do but to be instructed, every sound principle of education is outraged, and science is only made ridiculous.

This failure to gain the benefits of real scientific study has its source deep in the constitution of the public schools. In dealing with masses of children, classification became necessary, which gave rise, as we have seen, to grading and an elaborate mechanical system. The working of children in lots seems to be a necessity of the public schools, but it strengthens the practice of verbal instruction, recitations, and lesson-giving. It is well fitted to impress the public with the idea that there is much done in the schools. There are a prescribed routine of operations and a display of order that are admired. But teacher and learner are subordinated to the system. It is machine-work, and machines make no allowances. Gradation assumes and enforces a uniformity among pupils which is not according to the facts. Wide personal differences of capacity, aptitude, attainment, and opportunity, not only exist among children, but they are the prime data of all efficient mental cultivation. In the graded schools, just in proportion to the perfection of the mechanical arrangements, individuality disappears. Special original capacity, the main thing, counts for nothing. The mind can not be trained in such circumstances to originate its own judgments. The exercise of original mental power, or independent inquiry, is the very essence of the scientific method, and with this the practice of the public schools is at war. Moreover, a system which deals with the average mind, and does not get at the individual mind, breaks down at the point where all true education really begins, that is, in promoting self-culture. The value of educational systems consists simply in what they do to incite the pupil to help himself. Mechanical school-work can give instruction, but it can not develop faculty, because this depends upon self-exertion. Science, if rightly pursued, is the most valuable school of self-instruction. From the beginning men of science have been self-dependent and self-reliant because self-taught; and it is a question whether they have been most hindered or helped by the schools. De Candolle, in his valuable book on the conditions which favor the production of scientific men, says that the discoverers, the masters of scientific method, have chiefly appeared in small towns where educational resources have been scanty; and that they have often been most helped by the very poorness of their teaching, which threw them back upon themselves. It was to their advantage that the schools were not so perfect as to extinguish individuality and thus destroy originality.

Our strictures are here upon the general working of the public-school system; but we recognize that there are many exceptional teachers who do what they can to deal with science in the true spirit, while multitudes of instructors are chafing under present restrictions and groping after something better. The bad system is, moreover, continued chiefly from the lack of knowledge as to the possibilities of a better. But the better method of teaching science has been proved entirely practicable. The institution where we meet and many other science schools have shown it. A large number of teachers have demonstrated that various branches of science can be taught to the young by the true as well as by the false method. What is now most urgently needed is to gather from these experiences practical plans of improvement in science-teaching for the benefit of those who desire better guidance than they now have.

In his address as Rector of the University of Aberdeen, Professor Huxley said, "I would not raise a finger to introduce more book-work into every art curriculum in the country." We concur in this view, as applied to the present science-teaching in our public schools. We would not raise a finger to extend it.

President Barnard, of Columbia College, in a public address reprobating in severe terms the common method of teaching science as being an inversion of the true order of cultivating the mental faculties, referred to the great benefits which must arise "when our systems of education shall have been remodeled from top to bottom." That result may come about in the fullness of time, but it is wise to expect only a slow and gradual improvement. Vice-President Grote, in his St. Louis address, pointed out the guiding principle in this case as a substitution of real knowledge for second-hand information by a necessary law of mental advancement. In obedience to this principle, the cultivators of original science should do what they may to raise the standard of our prevalent science-teaching; and we respectfully ask that the Association will assign to a committee the duty of reporting at our next meeting on the best modes of improving the teaching of science in our public schools.

E. L. YOUMANS,
A. R. GROTE,
J. W. POWELL,
N. S. SHALER,
J. S. NEWBERRY,
} *Committee.*

THE CHEMISTRY OF COOKERY.

BY W. MATTIEU WILLIAMS.

I.—INTRODUCTORY SUGGESTIONS.

THE philosopher who first perceived and announced the fact that all the physical doings of man consist simply in changing the places of things made a very profound generalization, and one that is worthy of more serious consideration than it has received.

All our handicraft, however great may be the skill employed, amounts to no more than this. The miner moves the ore and the fuel from their subterranean resting-places, then they are moved into the furnace, and by another moving of combustibles the working of the furnace is started; then the metals are moved to the foundries and forges, then under hammers, or squeezers, or into melting-pots, and thence to molds. The workman shapes the bars, or plates, or castings, by removing a part of their substance, and by more and more movings of material produces the engine, which does its work when fuel and water are moved into its fireplace and boiler.

The statue is within the rough block of marble; the sculptor merely removes the outer portions, and thereby renders his artistic conception visible to his fellow-men.

The agriculturist merely moves the soil in order that it may receive the seed, which he then moves into it, and, when the growth is completed, he moves the result, and thereby makes his harvest.

The same may be said of every other operation. Man alters the position of physical things in such wise that the forces of Nature shall operate upon them and produce the changes or other results that he requires.

My reasons for this introductory digression will be easily understood, as this view of the doings of man and the doings of Nature displays fundamentally the business of human education, so far as the physical proceedings and physical welfare of mankind are concerned.

It clearly points out two well-marked natural divisions of such education: education or training in the movements to be made, and education in a knowledge of the consequences of such movements—i. e., in a knowledge of the forces of Nature which actually do the work when man has suitably arranged the materials.

The education ordinarily given to apprentices in the workshop, or the field, or the studio—or, as relating to my present subject, the kitchen—is the first of these; the second, and equally necessary, being simply and purely the teaching of physical science as applied to the arts.

I can not proceed any further without a protest against a very general (so far as this country is concerned) misuse of a now very popular term—a misuse that is rather surprising, seeing that it is accepted by scholars who have devoted the best of their intellectual efforts to the study of words. I refer to the word *technical* as applied in the designation "technical education."

So long as our workshops are separated from our science-schools and colleges, it is most desirable, in order to avoid continual circumlocution, to have terms that shall properly distinguish between the work of the two, and admit of definite and consistent use. The two words are ready at hand, and, although of Greek origin, have become by analogous usage plain, simple English. I mean the words *technical* and *technological*.

The Greek noun *techne* signifies an art, trade, or profession, and our established usage of this root is in accordance with this signification. Therefore "technical education" is a suitable and proper designation of the training which is given to apprentices, etc., in the strictly technical details of their trades, arts, or professions. When we require a name for the science or the philosophy of anything, we obtain it by using the Greek root *logos*, and appending it in English form to the Greek name of the general subject, as geology, the science of the earth; anthropology, the science of man; biology, the science of life, etc.

Why not, then, follow this general usage, and adopt "technology" as the science of trades, arts, or professions, and thereby obtain consistent and convenient terms to designate the two divisions of education—technical education, that given in the workshop, etc.; and technological education, that which should be given as supplementary to all such technical education?

In accordance with this, the papers I am here commencing will be a contribution to the technology of cookery, or to the technological education of cooks, whose technical education is quite beyond my reach.

The kitchen is a chemical laboratory, in which are conducted a number of chemical processes, by which our food is converted from its crude state to a condition more suitable for digestion and nutrition, and made more agreeable to the palate.

It is the *rationale* or *ology* of these processes that I shall endeavor to explain; but at the outset it is only fair to say that in many instances I shall not succeed in doing this satisfactorily, as there still remain some kitchen mysteries that have not yet come within the firm grasp of science. The *whole* story of the chemical differences between a roast, a boiled, and a raw leg of mutton, has not yet been told. You and I, gentle reader, aided by no other apparatus than a knife and fork, can easily detect the difference between a cut out of the saddle of a three-year-old Southdown and one from a ten-months-old meadow-fed Leicester; but the chemist in his laboratory, with all his re-agents, test-tubes, beakers, combustion-tubes, potash-bulbs, etc., etc., and his balance turning to one-thousandth of a grain, could not physically demonstrate the sources of these differences of flavor.

Still, I hope to show that modern chemistry can throw into the kitchen a great deal of light that shall not merely help the cook in doing his or her work more efficiently, but shall elevate both the work and the worker, and render the kitchen far more interesting to all intelligent people who have an appetite for knowledge, as well as for food, than it can be while the cook is groping in rule-of-thumb darkness—is merely a technical operator unenlightened by technological intelligence.

In the course of these papers I shall draw largely on the practical and philosophical work of that remarkable man, Benjamin Thompson, the Massachusetts prentice-boy and schoolmaster; afterward the British soldier and diplomatist, Colonel Sir Benjamin Thompson; then colonel of horse and general aide-de-camp of the Elector Charles Theodore, of Bavaria; then major-general of cavalry, Privy Councilor of State, and head of War Department of Bavaria; then Count Rumford of the Holy Roman Empire, and order of the White Eagle; then Military Dictator of Bavaria, with full governing powers during the absence of the Elector; then a private resident in Brompton Road, and founder of the Royal Institution in Albemarle Street; then a Parisian *citoyen*, the husband of the "Goddess of Reason," the widow of Lavoisier; but above all a practical and scientific cook, whose exploits in economic cookery are still but very imperfectly appreciated, though he himself evidently regarded them as the most important of all his varied achievements.

His faith in cookery is well expressed in the following, where he is speaking of his experiments in feeding the Bavarian army and the poor of Munich. He says: "I constantly found that the richness or quality of a soup depended more upon the proper choice of the ingredients, and a proper management of the fire in the combination of these ingredients, than upon the quantity of solid nutritious matter employed; much more upon the art and skill of the cook than upon the sums laid out in the market."

A great many fallacies are continually perpetrated, not only by ignorant people, but even by eminent chemists and physiologists, by inattention to what is indicated in this passage. In many chemical and physiological works may be found elaborately minute tables of the chemical composition of certain articles of food, and with these the assumption (either directly stated, or implied, as a matter of course) that such tables represent the practical nutritive value of the food. The illusory character of such assumption is easily understood. In the first place, the analysis is usually that of the article of food in its raw state, and thus all the chemical changes involved in the process of cookery are ignored.

Secondly, the difficulty or facility of assimilation is too often unheeded. This depends both upon the original condition of the food and the changes which the cookery has produced—changes which may double its nutritive value without effecting more than a small percentage of alteration in its chemical composition, as revealed by laboratory analysis.

In the recent discussion on whole-meal bread, for example, chemical analyses of the bran, etc., are quoted, and it is commonly assumed that, if these can be shown to contain more of the theoretical bone-making or brain-making elements, they are, therefore, in reference to these requirements, more nutritious than the fine flour. But, before we are justified in asserting this, it must be made clear that these ordinarily rejected portions of the grain are as easily digested and assimilated as the finer inner flour.

I think I shall be able to show that the practical failure of this whole-meal bread movement (which is not a novelty, but only a revival) is mainly due to the disregard of the cookery question; that whole-meal prepared as bread by simple baking is less nutritious than fine flour similarly prepared; but that whole-meal otherwise prepared may be, and has been, made more nutritious than fine white bread.

Count Rumford supplies us with important data toward the solution of this difficulty.

Another preliminary example. A pound of bread or biscuit contains more solid nutritive matter than a pound of beefsteak, but does not, when eaten by ordinary mortals, do so much nutritive work. Why is this?

It is a matter of preparation—not exactly what is called cooking, but equivalent to what cooking should be. It is the preparation which has converted the grass-food of the ox into another kind of food which we can assimilate very easily.

The fact that we use the digestive and nutrient apparatus of sheep, oxen, etc., for the preparation of our food is merely a transitory barbarism, to be ultimately superseded when my present subject is sufficiently understood and applied to enable us to prepare the constituents of the vegetable kingdom in such a manner that they shall be as easily assimilated as the prepared grass which we call beef and mutton, and which we now use only on account of our ignorance of "The Chemistry of Cooking."

II.—THE BOILING OF WATER.

As this is one of the most rudimentary of the operations of cookery, and the most frequently performed, it naturally takes a first place in treating the subject.

Water is boiled in the kitchen for two distinct purposes: 1. For the cooking of itself; 2. For the cooking of other things. A dissertation on the difference between raw water and cooked water may appear pedantic, but, as I shall presently show, it is considerable, very practical, and important.

The best way to study any physical subject is to examine it experimentally, but this is not always possible with every-day means. In this case, however, there is no difficulty.

Take a thin* glass vessel, such as a flask, or, better, one of the "beakers," or thin, tumbler-shaped vessels, so largely used in chemical laboratories; partially fill it with ordinary household water, and then place it over the flame of a spirit-lamp, or Bunsen's, or other smokeless gas-burner. Carefully watch the result, and the following will be observed: First of all little bubbles will be formed, adhering to the sides of the glass, but ultimately rising to the surface, and there becoming dissipated by diffusion in the air.

This is not boiling, as may be proved by trying the temperature with the finger. What, then, is it?

It is the yielding back of the atmospheric gases which the water has dissolved or condensed within itself. These bubbles have been collected and by analysis proved to consist of oxygen, nitrogen, and carbonic acid, obtained from the air; but in the water they exist by no means in the same proportions as originally in the air, nor in constant proportions in different samples of water. I need not here go into the quantitative details of these proportions, nor the reasons of their variation, though they are very interesting subjects.

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* In applying heat to glass vessels, thickness is a source of weakness or liability to fracture, on account of the unequal expansion of the two sides, due to inequality of temperature, which, of course, increases with the thickness of the glass. Besides this, the thickness increases the leverage of the breaking strain.

Proceeding with our investigation, we shall find that the bubbles continue to form and rise until the water becomes too hot for the finger to bear immersion. At about this stage something else begins to occur. Much larger bubbles, or rather blisters, are now formed on the bottom of the vessel, immediately over the flame, and they continually collapse into apparent nothingness. Even at this stage a thermometer immersed in the water will show that the boiling-point is not reached. As the temperature rises, these blisters rise higher and higher, become more and more nearly spherical, finally quite so, then detach themselves and rise toward the surface; but the first that make this venture perish in the attempt—they gradually collapse as they rise, and vanish before reaching the surface. The thermometer now shows that the boiling-point is nearly reached, but not quite. Presently the bubbles rise completely to the surface and break there. Now the water is boiling, and the thermometer stands at 212° Fahr. or 100° Cent.

With the aid of suitable apparatus it can be shown that the atmospheric gases above named continue to be given off along with the steam for a considerable time after the boiling has commenced; the complete removal of their last traces being a very difficult, if not an impossible, physical problem.

After a moderate period of boiling, however, we may practically regard the water as free from these gases. In this condition I venture to call it cooked water. Our experiment so far indicates one of the differences between cooked and raw water. The cooked water has been deprived of the atmospheric gases that the raw water contained. By cooling some of the cooked water and tasting it the difference of flavor is very perceptible; by no means improved, though it is quite possible to acquire a preference for this flat, tasteless liquid.

If a fish be placed in such cooked water it swims for a while with its mouth at the surface of the water, for just there is a film that is reacquiring its charge of oxygen, etc., by absorbing it from the air; but this film is so thin and so poorly charged, that after a short struggle the fish dies for lack of oxygen in its blood, drowned as truly and completely as a living, breathing animal when immersed in any kind of water.

Spring and river water that have passed through or over considerable distances in calcareous districts suffer another change in boiling. The origin and nature of this change may be shown by another experiment as follows: Buy a pennyworth of lime-water from a druggist, and procure a small glass tube of about quill-size, or the stem of a fresh tobacco-pipe may be used. Half fill a small wine-glass with the lime-water, and blow through it by means of the tube of the tobacco-pipe. Presently it will become turbid. Continue the blowing, and the turbidity will increase up to a certain degree of milkiness. Go on blowing with "commendable perseverance," and an inversion of effect will follow: the turbidity diminishes, and at last the water becomes clear again.

The chemistry of this is simple enough. From the lungs a mixture of nitrogen, oxygen, and carbonic acid is exhaled. The carbonic acid combines with the soluble lime and forms a carbonate of lime which is insoluble in mere water. But this carbonate of lime is to a certain extent soluble in water saturated with carbonic acid, and such saturation is effected by the continuation of blowing.

Now take some of the lime-water that has been thus treated, place it in a clean glass flask, and boil it. After a short time the flask will be found incrusted with a thin film of something. This is the carbonate of lime, which has been thrown down again by the action of boiling in drawing off its solvent, the carbonic acid. This crust will effervesce if a little acid is added to it.

In this manner our tea-kettles, engine-boilers, etc., become incrusted when fed with calcareous waters, and most waters are calcareous; those supplied to London, which is surrounded by chalk, are largely so. Thus the boiling or cooking of such water effects a removal of its mineral impurities more or less completely. Other waters contain such mineral matter as salts of sodium and potassium. These are not removable by mere boiling.

Usually we have no very strong motive for removing either these or the dissolved carbonate of lime, or the atmospheric gases from water, but there is another class of impurities of serious importance. These are the organic matters dissolved in all water that has run over land covered with vegetable growth, or, more especially, which has received contributions from sewers or any other form of house-drainage. Such water supplies nutriment to those microscopic abominations, the *mirococci*, *bacilli*, *bacteria*, etc., which are now shown to be connected with blood-poisoning—possibly do the whole of the poisoning business. These little pests are harmless, and probably nutritious, when cooked, but in their raw and wriggling state are horribly prolific in the blood of people who are in certain states of what is called "receptivity." They (the bacteria, etc.) appear to be poisoned or somehow killed off by the digestive secretions of the blood of some people, and nourished luxuriantly in the blood of others. As nobody can be quite sure to which class he belongs, or may presently belong, or whether the water supplied to his household is free from blood-poisoning organisms, cooked water is a safer beverage than raw water.

The requirement for this simple operation of cooking increases with the density of our population, which on reaching a certain degree renders the pollution of all water obtained from the ordinary sources almost inevitable.

Reflecting on this subject, I have been struck with a curious fact that has hitherto escaped notice, viz., that, in the country which over all others combines a very large population with a very small allowance of cleanliness, the ordinary drink of the people is boiled water flavored by an infusion of leaves. These people, the Chinese, seem, in fact, to have been the inventors of boiled-water beverages. Judging from travelers' accounts of the state of the rivers, rivulets, and general drainage and irrigation arrangements of China, its population could scarcely have reached its present density if Chinamen were drinkers of raw instead of cooked water.

III.—COOKING UNDER WATER.

Next to the boiling of water for its own sake, as treated in my last, comes the boiling of water as a medium for the cooking of other things. Here, at the outset, I have to correct an error of language which, as too often happens, leads by continual suggestion to false ideas. When we speak of "boiled beef," "boiled mutton," "boiled eggs," "boiled potatoes," we talk nonsense; we are not merely using an elliptical expression, as when we say "the kettle boils," which we all understand to mean the contents of the kettle, but we are expounding a false theory of what has happened to the beef, etc.—as false as though we should describe the material of the kettle that has held boiling water as boiled copper or boiled iron. No boiling of the food takes place in any such cases as the above-named—it is merely heated by immersion in boiling water; the changes that actually take place in the food are essentially different from those of ebullition. Even the water contained in the meat is not boiled in ordinary cases, as its boiling-point is higher than that of the surrounding water, owing to the salts it holds in solution.

Thus, as a matter of chemical fact, a "boiled leg of mutton" is one that has been cooked, but not boiled; while a roasted leg of mutton is one that has been partially boiled. Much of the constituent water of flesh is boiled out, fairly driven away as vapor during roasting or baking, and the fat on its surface is also boiled, and, more or less, dissociated into its chemical elements, carbon and water, as shown by the browning, due to the separated carbon.

As I shall presently show, this verbal explanation is no mere verbal quibble, but it involves important practical applications. An enormous waste of precious fuel is perpetrated every day, throughout the whole length and breadth of Britain and other countries where English cookery prevails, on account of the almost universal ignorance of the philosophy of the so-called boiling of food.

When it is once fairly understood that the meat is not to be boiled, but is merely to be warmed by immersion in water raised to a maximum temperature of 212°, and when it is further understood that water can not (under ordinary atmospheric pressure) be raised to a higher temperature than 212° by any amount of violent boiling, the popular distinction between "simmering" and boiling, which is so obstinately maintained as a kitchen superstition, is demolished.

The experiment described in my last showed that immediately the bubbles of steam reach the surface of the water and break there—that is, when simmering commences—the thermometer reaches the boiling-point, and that however violently the boiling may afterward occur, the thermometer rises no higher. Therefore, as a medium for heating the substance to be cooked, simmering water is just as effective as "walloping" water. There are exceptional operations of cookery, to be described hereafter, wherein useful mechanical work is done by violent boiling; but in all ordinary cookery, simmering is just as effective. The heat that is applied to do more than the smallest degree of simmering is simply wasted in converting water into useless steam. The amount of such waste may be easily estimated. To raise a given quantity of water from the freezing to the boiling point demands an amount of heat represented by 180° in Fahrenheit's thermometer, or 100° Centigrade. To convert this into steam, 990° Fahr. or 500° Cent. is necessary—just five and a half times as much.

On a properly-constructed hot-plate or sand-bath, a dozen saucepans may be kept at the true cooking temperature, with an expenditure of fuel commonly employed in England to "boil" one saucepan. In the great majority of so-called boiling operations, even simmering is unnecessary. Not only is a "boiled leg of mutton" not itself boiled, but even the water in which it is cooked should not be kept boiling, as we shall presently see.

In order to illustrate some of the changes which take place in the cooking of animal food, I will first take the simple case of cooking an egg by means of hot water. These changes are in this case easily visible and very simple, although the egg itself contains all the materials of a complete animal. Bones, muscles, viscera, brain, nerves, and feathers of the chicken—all are produced within the shell, nothing being added, and little or nothing taken away.

When we open a raw egg, we find, enveloped in a stoutish membrane, a quantity of glairy, slimy, viscous, colorless fluid, which, as everybody now knows, is called *albumen*, a Latin translation of its common name, "*the white.*" Within the white of the egg is the yolk, largely composed of that same albumen, but with other constituents added—notably a peculiar oil. At present I will only consider the changes which cookery effects on the main constituent of the egg, merely adding that this same albumen is one of the most important, if not the one most important, material of animal food, and is represented by a corresponding nutritious constituent in vegetables.

We all know that when an egg has been immersed during a few minutes in boiling water, the colorless, slimy liquid is converted into the white solid to which it owes its name. This coagulation of albumen is one of the most decided and best understood changes effected by cookery, and therefore demands especial study.

Place some fresh, raw white of egg in a test-tube, or other suitable glass vessel, and in the midst of it immerse the bulb of a thermometer. (Cylindrical thermometers, with the degrees marked on the glass stem, are made for such laboratory purposes.) Place the tube containing the albumen in a vessel of water, and gradually heat this. When the albumen attains a temperature of about 134° Fahr., white fibers will begin to appear within it ; these will increase until about 160° is attained, when the whole mass will become white and nearly opaque. It is now coagulated, and may be called solid. Now examine some of the result, and you will find that the albumen thus only just coagulated is a tender, delicate, jelly-like substance, having every appearance to sight, touch, and taste of being easily digestible. This is the case.

Having settled these points, proceed with the experiment by heating the remainder of the albumen (or a new sample) up to 212°, and keeping it for a while at this temperature. It will dry, shrink, and become horny. If the heat is carried a little further, it becomes converted into a substance which is so hard and tough that a valuable cement is obtained by simply smearing the edges of the article to be cemented with white of egg, and then heating it to a little above 212°.*

This simple experiment teaches a great deal of what is but little known concerning the philosophy of cookery. It shows in the first place that, so far as the coagulation of the albumen is concerned, the cooking temperature is not 212°, or that of boiling water, but 160°, i. e., 52° below it. Everybody knows the difference between a tender, juicy steak, rounded or plumped-out in the middle, and a tough, leathery abomination, that has been so cooked as to shrivel and curl up. The contraction, drying up, and hornifying of the albumen in the test-tube represent the albumen of the latter, while the tender, delicate, trembling, semi-solid, that was coagulated at 160°, represents the albumen in the first.

But this is a digression, or rather anticipation, seeing that the grilling of a beefsteak is a problem of profound complexity that we can not solve until we have mastered the rudiments. We have not yet determined how to practically apply the laws of albumen coagulation as discovered by our test-tube experiment to the cooking of a breakfast-egg.—*Knowledge.*

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* "Egg-cement," made by thickening white of egg with finely-powdered quicklime, has long been used for mending alabaster, marble, etc. For joining fragments of fossils and mineralogical specimens, it will be found very useful. White of egg alone may be used, if carefully heated afterward.

OUR MARRIAGE AND DIVORCE LAWS.

By GORDON A. STEWART.

THE worst of our social evils, personal wrongs, and political sins arise from the ununiform operation of our marriage and divorce laws. The loose manner in which a contract of marriage may be entered into and the reckless facility with which a marriage contract may be dissolved are a disgrace to our high civilization and professed Christianity. However learned commentators and jurists may differ as to the correct definition of marriage, it is not only a partially executed agreement to marry, but is a contract continuous in its obligations governing the status of the parties, until it is dissolved by the death of one of the parties, or by one of them obtaining a divorce for some wrongful or invalidating act committed by the other.

In nearly all of the States marriage is recognized as a civil contract only, and has no ecclesiastical obligation so far as society and the State are concerned. The contracting parties are subjects of the law. The person performing the ceremony by which the contract is publicly acknowledged by the parties, whether he be magistrate, parson, or layman, becomes a civil officer by authority of the law for that occasion. Generally, however, the marriage contract is solemnized by a clergyman, agreeably to the rules and regulations of the religious denomination to which he belongs, and for which one or the other of the parties has a religious attachment or preference ; or, because a religious solemnization in church gives a better opportunity to gratify the desire for social rivalry and display. But perhaps most persons, especially when young and looking forward to a long future of connubial happiness, consider the act of marriage more as a religious rite than a civil contract, and hence the forms and ceremonies of the Church accord more agreeably with the sentiment of love and affection than the business-like and informal words of the magistrate, who, in response to their acknowledgment of intention to marry, simply pronounces them man and wife. This sentiment, no doubt, is largely the result of a lingering belief in marriage as a divine institution and a sacrament of the Church, as taught when the ecclesiastical court had exclusive jurisdiction of marriage and divorce. It is perhaps not until later, not until they have become dissatisfied with the conditions of the solemn obligation they had agreed to faithfully perform through life, that they discover it is simply a civil contract that binds them, and from which the law has generously provided unlimited means of escape.

Lawful marriage is the basis of the family relation, and the family relation is the fundamental principle of association upon which the superstructure of society and the State is built. And yet there is no contract of the value of twenty dollars, subject to the verdict of a jury or the decision of a court, that is so easily avoided and so shamefully dissolved as the contract of marriage. The facts show that the law and the courts enforce the obligations of a delinquent debtor with more severity than the obligations of this contract upon which the happiness of the family, the morality of society, and the perpetuity of the State depend. The marriage contract is of a higher inspiration, and has a broader obligation, than a mere contract for the payment of money, or for the transfer of property, or for co-operation in business. It is one in which society is more deeply interested, one by which society is more seriously affected; and society has the right to demand that the mutual obligations shall be faithfully kept and lawfully enforced.

This lack of uniformity in the laws, both in their formulation and execution, is the result of the diversity of sources from which they emanate. Each State is its own authority, and determines for itself the conditions upon which the marriage relation of its people may be entered into or dissolved; and, perhaps, the social and moral sentiment of the people of a State can not be more equitably determined than by observing the character and use of its laws governing marriage and divorce; forthe various degrees of restriction and laxity in marriage and divorce have marked the progress and decline of all peoples and nations ever since the days when Adam and Eve went out of paradise and Moses wrote the law on Mount Sinai. Several States still retain upon their statute-books the common-law prohibition of marriage between persons related by consanguinity, or affinity, nearer than the third degree; while other States have progressed to that degree of liberality on the road to individual freedom and universal happiness which permits a person to marry, if not his grandmother, at least the daughter of his wife by a former husband. So we find that while two persons within certain degrees of relationship may lawfully marry in one State, they are prohibited from marrying by the laws of another State; and that while a marriage between certain persons is voidable only in one State, it is absolutely void under a similar law in another State.

It would be interesting to review at length the marriage and divorce laws of the several States, and note their want of uniform operation; but, for the purposes of this article, which must be brief, I shall confine myself to a comparative notice of the laws of two or three States only. In Ohio, "male persons of the age of eighteen years, and female persons of the age of sixteen years, not nearer kin than second-cousins, and not having a husband or wife living, may be joined in marriage," provided that if the male person is under the age of twenty-one, and the female person is under the age of eighteen, they shall first obtain the consent of their parents, respectively. The marriage may be solemnized by an ordained minister of any religious congregation who has first obtained a license authorizing him to solemnize marriages; or by a justice of the peace in his county; or by the several religious societies agreeably to the rules and regulations of their respective churches. If the parties are married by the rules of any church, notice of the marriage must first be published in the presence of the congregation on two separate days of worship, the first notice to be at least ten days previous to such marriage, and in the county in which the female resides. And, in order that record evidence of a marriage may always exist, a license to marry must first be obtained from the probate court before the marriage can be legally solemnized; and a certificate of such marriage, signed by the minister or justice of the peace solemnizing the same, must be filed by the person so officiating with the court where the license issued. This certificate must be filed with the court within three months from date of marriage, under a penalty of fifty dollars fine for neglect to do so, and the court must make a record of the certificate of marriage under a like penalty. These last provisions do not apply to parties who are married by the rules of any church.

In New York, marriage, so far as its validity in law is concerned, is expressly declared to be a civil contract, to which the consent of the parties, who must be capable in law of contracting, is essential. Marriage between parents and children, and grandparents and grandchildren, of every degree, and between brothers and sisters of the half or whole blood, are declared to be incestuous and absolutely void. So a second or other subsequent marriage contracted by any person during the lifetime of any former husband or wife of such person, is absolutely void, unless the marriage of such former husband or wife shall have been annulled for some cause other than the adultery of such person, or unless such former husband or wife shall have been finally sentenced to imprisonment for life. But for causes existing at the time of marriage, where either of the parties is incapable of contracting for want of age or understanding, or from physical causes, or where consent has been obtained through force or fraud, the marriage is void only from the time its nullity shall be declared by a court of competent authority. So, if any person, whose husband or wife shall have absented himself or herself for the space of five consecutive years without being known to such person to be living during that time, shall marry during the lifetime of such absent husband or wife, the marriage shall be void only from the time its nullity is pronounced by a court of competent authority. The law authorizing a legal separation, or a limited divorce, in New York, has been repealed, and the only causes arising after marriage for which a legal marriage can be annulled are adultery and imprisonment for life; and a pardon to the person sentenced to imprisonment for life will not restore to him or her the rights of a previous marriage. In a case of divorce for adultery the complainant may marry again during the life of the defendant; but no defendant convicted of adultery can marry again until the death of the complainant, unless the court in which the judgment of divorce was rendered shall modify such judgment on satisfactory proof that the complainant has remarried, that five years have elapsed since the divorce was granted, and that the conduct of the defendant since the dissolution of the marriage has been uniformly good.

No formality is necessary for the solemnization of marriages in New York. But, for the purpose of being registered and authenticated, the statute provides that marriages may be solemnized by ministers of the gospel and priests; and when solemnized by them the ceremony must be according to the forms and customs of the church or society to which they belong. Marriages may also be solemnized by mayors, recorders, and aldermen of cities, judges of the county court, justices of the peace, and by justices and judges of courts of record. When solemnized by a magistrate, no particular form is required, except that the parties shall declare in the presence of the magistrate and attending witnesses that they take each other for husband and wife. It is the duty of the officiating minister or magistrate to enter the names, ages, and residences of the parties, and the witnesses to the marriage, in a book to be kept for that purpose, and he shall upon application furnish to the parties a certificate of such marriage. This certificate, if presented to the clerk of the city or town where the marriage was solemnized, or where either of the parties resides, shall be filed by such clerk and entered in a book. The entry, or a certified copy thereof, or the marriage certificate, shall be received as evidence of such marriage. The provisions of the law regulating the solemnization of marriages, however, do not apply to the people called Quakers, nor to Jews, who are married according to the regulations of their respective churches.

In Connecticut the statute declares that no man shall marry his mother, grandmother, daughter, granddaughter, sister, aunt, niece, step-mother or step-daughter; that no woman shall marry her father, grandfather, son, grandson, brother, uncle, nephew, step-father, or step-son; and that, if any man or woman shall marry within the degrees aforesaid, such marriage shall be void. It provides further that no persons shall be married until one of them shall inform the register of the town, or the town-clerk, in which the marriage is to be celebrated, of the name, age, color, occupation, birthplace, residence, and condition—whether single, widowed, or divorced—of each. Such register, or town-clerk, shall thereupon issue his certificate that the parties therein named have complied with the law, which certificate shall be a license for any person authorized to solemnize marriages to give in marriage, in said town only, the parties therein named; but no such certificate shall be issued if either of the parties is a minor, under the control of a parent or a guardian, until such parent or guardian shall give to the register, or town-clerk, his written consent; and any register, or town-clerk, who shall knowingly issue such certificate without such consent, shall forfeit to the State one hundred dollars; and any person who shall join any persons in marriage without having received such certificate shall forfeit a like sum of one hundred dollars. Every person who shall join any persons in marriage shall certify upon the license certificate the fact, time, and place of such marriage, and return it to the register of the town where it was issued, before or during the first week of the month next succeeding such marriage, and upon failure thereof shall forfeit ten dollars. The certificate shall be *prima facie* evidence of such marriage. All judges, justices of the peace, and ordained or licensed clergymen while in the ministry, may join persons in marriage, and all marriages attempted to be celebrated by any other person shall be void; but all marriages which shall be solemnized according to the forms and usages of any religious denomination in the State shall be valid.

While the laws of these three States differ—and, perhaps, no two States in the Union agree as to who are competent to contract marriage—the provisions of the statutes of each regulating its solemnization would seem to be sufficient to protect society against hasty and indiscriminate alliances, to guard either party against fraud, and to furnish record evidence in any case where proof of marriage might be required. And yet, upon the provisions of the statutes defining *who* may solemnize marriages, the greatest confusion prevails throughout the Union between the courts and the law. In Connecticut, we have seen that "all marriages attempted to be celebrated by any other person" (than those named) "shall be void." In Ohio and New York, and in many other States, where no words of nullity are expressed in the statutes, such marriages are held valid.

But in Massachusetts, and in several other States, it has been held, where no words of nullity are expressed, that such marriages are not valid. And yet, it is generally accepted as the law, on principle, notwithstanding the marriage is celebrated without license, and the ceremony performed by an unauthorized person, that if the parties simply by mutual consent agree to marry, and live together as man and wife, such consent and cohabitation are valid and binding between the parties, and the issue thereof are entitled to all the rights of legitimate children. To reverse this common-law doctrine by general statutory provisions might work hardship in some individual cases; but its existence works more harm to society and bastardizes more children than would the enactment of stringent marriage laws, for parties would then be more careful and not enter into such relation without proof of marriage. Marriage is not a contract to be entered into in haste and repented of at leisure. It is of more importance to the parties, and far more to society, than the acquirement of a good title to a piece of real estate. Yet no one would think it a hardship to comply with the law for the proper execution and registration of a deed of conveyance, and no court would hold, as a general rule, that a valid title passed, although the statute governing the transfer had not been complied with.

In these three States, and in most of the States, the laws regulating the solemnization of marriages except from their general provisions certain religious denominations. This exception was an early spasm of religious toleration, entirely out of date in this tolerant age. Marriage being a civil contract between two persons, its conditions should be performed by them, of whatever religious faith they may be, the same as they would have to perform the conditions of any other civil contract or legal obligation. The exception is anti-constitutional, in establishing a religious distinction even as against the Catholic Church, which still holds marriage as a divine institution, and its celebration a sacrament of the Church. No such exception is made in the execution of any other legal contract or in favor of other religious sects, and no hardship or violation of conscience or religious belief could follow the abolition of this incongruity. As members of society and citizens of the State, all persons should conform to the same civil law, leaving the individual parties free to supplement the civil ceremony with a religious one, according to the rules of the religious society to which they belong.

There is a peculiarity in the marriage contract, that does not enter into any other contract in the ordinary commercial transactions of life. While others may be, it must be between one man and one woman only. The contract does not end with the marriage ceremony; its conditions are for life, and continue until dissolved by death or divorce. Once it might have been considered to end with the solemnization, and to take on the form of a status, but that was in those days when on the "nuptial day" all the identity of the woman, her personality, individuality, right of property, and control of offspring, were merged in the man, and he became her lord and master, leaving her without the right of appeal to any civil authority for the redress of any wrong. But the barbarism of those days is fading away, and the light of a new civilization is dawning, though still confused here and there by old forms and prejudices. When woman shall stand before the law equal with man in all her personal, property, and political rights, then indeed will marriage be a contract sanctioned by nature and approved by God. All the instincts of nature favor marriage, all the passions, desires, and affections of the human heart enter into it, and the highest development of the human race depends upon it. Yet, as a part of the contract, the law of divorce enters in; and, while it is over-rigid in some States, in others its laxity almost neutralizes the fundamental idea of the continuance and perpetuity of the marriage obligation.

As a relic of that "peculiar institution," with its concubinal practice between whites and blacks, South Carolina preserves its old laws which allow no cause for divorce. In New York there is one cause only. In Ohio and other States there are many; but in Connecticut, Indiana, Illinois, North Carolina, and Maine, there is any cause that a discontented and dishonest party may allege, or that a judge in his discretion, influenced by sympathy or corrupt motives, may approve. In these extremes of the law, we have the tyranny of bigotry and the liberty of license, this opening the gates of temptation to the licentiousness of man, and the other driving in the victims. Surely there is a happy medium sufficiently circumscribed to restrain the vicious and dishonest, and yet liberal enough to afford relief to the innocent and injured! Thus, it will be seen that uniformity in the operation of the divorce laws, as a part of the marriage contract, is made necessary by the facility with which divorces are now "made easy, and without publicity." The cases where a husband or wife has abandoned home and family, and gone into a neighboring State to procure a divorce that could not be obtained at home, are so frequent and notorious, that the public conscience has ceased to be more shocked over such an occurrence than over a bank-president's embezzlement, or a willful murder. And yet society should be shocked to the very depths of humiliation, for the histories of the majority of such cases show that they are instigated by the basest motives of the human heart. For some fancied or real grievance that could easily be explained by love, or remedied by law; for the slightest incompatibility that could exist between any two independent individuals, and which might be softened by intelligent forbearance, but which must be endured by all under any form of contract; or, from a sensual desire to form another marriage relation, or for apparent causes that have no deeper root of evil than fashionable folly, petty jealousy, and irritability of temper—the laws of many of the States offer a way for the dissolution of the marriage contract. It is, however, to the credit of our humanity that the noble and enduring men and women of our race—those upon whom the world must ever rely for the true advancement of man toward social perfection and individual happiness—seldom or never resort to the courts, even of their own State, for release from a contract which may have become onerous or even disgraceful to bear. Under the present liberal laws, regulating the relation of husband and wife, in some of the more progressive States, the parties stand so nearly equal before the law as individuals, in their personal and property rights, that there can not be the same excuses for resorting to divorce as a remedy for a real or supposed wrong, and certainly not the necessity for the assignment of so many statutory causes, as in former years. And while there should be other causes than adultery assigned for divorce, there is no other cause by which the family and society can be so deeply injured; no other cause that might not be adjusted between the parties, or removed by law, the same as if the marriage relation did not exist, or for which the innocent party might not suffer just as severely in his or her relation to society as in the relation of husband or wife.

Although New York has experimented with both a prohibitory and a liberal policy of divorce, long years of experience have demonstrated that the peace and happiness of the family and the purity of public morals are best subserved by a restrictive policy; yet no State in the Union can boast of a larger personal freedom of its citizens, or a higher standard of intelligence and morality. The percentage of illiteracy is comparatively small; woman is held in the highest esteem, and on all school questions has the equal right of suffrage; she is better protected in her personal and property rights than elsewhere; and, so far as the domestic relations are concerned, no State has a happier or a more contented people. The rural population is prosperous and happy in its Arcadian simplicity; and even in the great commercial metropolis of the State, where the opportunity for temptation and crime, corruption, and luxurious licentiousness, is so great, the intelligence and morals of the people are equal to those of any city in the world. Notwithstanding this, the laws of other States and the decisions of the courts make marriage in New York, as elsewhere, a contract subject to the caprice or dishonesty of either of the parties.

Parties who legally marry know the conditions of the contract into which they have entered. In New York they know that, as a part of the contract, so long as they reside in the State there is one cause only, except death, for its dissolution. And so long as one of the parties to a marriage continues to reside in the State in which the contract was made, and under the protection of its laws, no other State, into which the other party may have removed for the purpose of obtaining a divorce, should assume jurisdiction of the contract, or change its terms, so as to annul it for any other cause than that which existed in the State where the contract was made, and then only after obtaining personal service upon the non-resident defendant. It is questionable, as a matter of individual right, whether any State into which the parties may have mutually agreed to remove should assume jurisdiction to set aside the marriage contract for any other cause than could be assigned in the State in which the contract was made. Certainly one State should respect the laws of another, as it would have its own laws respected by the other. But the question of jurisdiction and domicile in interstate divorce has perplexed the courts almost endlessly. The general principle of law that the domicile of the wife remains with or follows the husband is limited by the reasons on which it rests, and must be varied according to the circumstances of the case, so that for the purpose of divorce each party is said to have a separate domicile. When one of the parties removes into another State for the purpose of divorce, and, after gaining a legal residence there, commences proceedings for divorce, how can the court, if marriage is a contract, get personal service upon the defendant so as to affect the rights of this non-resident party? Or, if marriage is a status, and the court takes cognizance only of the condition of the plaintiff, *it*, the condition of the plaintiff, being within the jurisdiction of the court, why is it necessary to bring the non-resident party into court even by constructive service? Divorce in either case will not change the relation of the non-resident party to the laws of the State in which he or she resides; it might, if it were the woman who obtained the divorce, leave the husband a married man without a wife, or, if it were he who obtained the divorce, leave her a married woman without a husband; and if the one thus left should marry again, though the marriage should be held legal, he or she might be punished under the laws of the State for bigamy or adultery. Such is the right of sovereignty each State has over its own subjects. But no State should take jurisdiction to dissolve a marriage contract between parties not situated in a way to render the sentence of dissolution binding, on general principles of law, upon every other State. Yet it is so often done that the cases in one State to set aside divorces obtained in another State are notoriously frequent. There is no subject so intermixed with so much legal rubbish and confusion, none in relation to which there is so much diversity of law and judicial conflict and uncertainty, as that relating to marriage, whether considered as a contract or a status, and none to which the statesman should more earnestly address himself to relieve it of these absurd legal perplexities. But how can uniformity be attained after so many long years of confusion?

Congress should pass a law establishing uniform rules of marriage and divorce throughout the United States. It should declare that the marriage contract is of that kind within the meaning of the Constitution which declares that "no State shall pass any law impairing the obligation of contracts." Where both the parties are domiciled in the same State, it should leave them subject to the laws of the State in which they reside; but, when they become "citizens of different States" for the purpose of divorce, it should require the suit to be brought in the United States courts; and perhaps when woman, as a citizen, becomes co-equal with man before the law, it will in such cases be obliged to do so. This would give the courts jurisdiction of both parties, or the status of both parties, without resorting to legal subterfuge or fiction; and would, where the suit was between "citizens of different States," preserve the individual sovereignty and dignity of the two States. It would also harmonize the foregoing provision of the Constitution which declares that "no State shall pass any law impairing the obligation of contracts," with the provision which also declares that "full faith and credit shall be given in each State to the *public acts*, records, and judicial proceedings of every other State"—a harmony that has never heretofore existed. The obligation to give "full faith and credit" to the "public acts" and "judicial proceedings" of a State is reciprocal between States; how then, when the "public acts" of two States are in conflict on the subject of divorce, can one State, in a judicial proceeding by a resident of its own, determine the relation of a citizen of another State to *its laws?* How can it impair the obligation of a contract or annul a status between parties, over one of whom it has no jurisdiction, and at the same time give "full faith and credit" to the "public acts" of the other State?

That Congress has the constitutional power to pass a law establishing uniform rules of marriage and divorce in the District of Columbia and all the Territories of the United States is beyond question. That it has not the power to pass a law establishing such rules throughout the United States can only be asserted. "Congress shall have power to establish a uniform rule of naturalization and uniform *laws* on the subject of *bankruptcies* throughout the United States"; and who can conceive of a person being more of a bankrupt in home and fortune than one who has a faithless wife or husband? Certainly in that view, with the marriage declared a contract within the meaning of the Constitution and its violation a species of bankruptcy, a general bankrupt law might give the courts jurisdiction to relieve a faithful husband or dutiful wife of the onerous conditions of a contract by the assignment of such assets as a worthless wife or husband to a generous and forgiving public.

There is another mode by which uniformity in the marriage and divorce laws of the States might be attained, whether the opinions of the judiciary could ever be harmonized or not, and that without impinging on the delicate question of State rights. Let Congress appoint commissioners to prepare a code of marriage and divorce laws for the District of Columbia and Territories of the United States, and invite each of the States to appoint a commissioner in its own behalf to unite with the commissioners appointed by Congress in forming a commission to codify and prepare a system of marriage and divorce, which, when passed by Congress and adopted by the several States, or any of them, shall have a uniform operation in the District of Columbia and Territories, and throughout the United States, or in those States adopting it. That there is an urgent necessity for Congress alone, or for Congress and the States united, to move earnestly in this matter, is not only seen in the ineffectual efforts of Congress every year to suppress polygamy, which is fast spreading from Utah into the other Territories, but also in an almost similar condition of society in the States, brought about by the ununiform laws and the conflicting decisions of the courts.

It is discreditable to civilization not to reverse a decision or principle of law, though of long standing, which is more evil in its continuance than inconvenient in its reversal or repeal. A thing which has outlived its influence for good, or a principle that has no longer an application to the progress of the age, in religion or law, should be abandoned. The spirit of the Constitution and the principles of interstate jurisdiction adjudicated under it have been insidiously directed, since the foundation of the government, to the national protection of and non-interference with a local institution which no longer exists. The reasons upon which those principles were based and the status in whose interest the decisions were formulated into law having passed away, it is time that the judicial mind should readjust itself to the demands of a newer condition of life and a higher civilization. But the conservative judicial mind is the last *phase of energy* in which the theory of evolution evolves, and "general principles of law" handed down by judicial prejudice from generation to generation are the last to give way in matters of progress and reform, not only when the reasons on which they were based no longer exist, but when other and better reasons demand a change.

There is another phase of this question which assumes a peculiar interest at the present time. It is that the marriageable portion of seven eighths of the citizens of the United States is interdicted from intermarrying with any one of the marriageable portion of the other one eighth of the citizens. Not that any one of the marriageable portion of the seven eighths, or of the one eighth, competent to contract marriage, is prohibited from marrying; but if love, admiration, pecuniary interest, or convenience, should move one of the marriageable portion of the seven eighths to desire in marriage one of the marriageable portion of the one eighth who reciprocates the love, admiration, pecuniary interest, or convenience of the other, the law interferes and makes such marriage a criminal offense! Why? Because of a prejudice held by the seven eighths against the one eighth—held for the reason that all of the one eighth are related in a near or remote degree to a race that was for centuries held as slaves to the other. It is a prejudice, not so much against "color" as against "previous condition"—color being a legal designation to identify the individual with the proscribed race.

Marriage is a natural right into which the question of color does not enter except as an individual preference expressed by the parties to the marriage. It is so recognized by the laws of all nations except our own, though in a few States this natural right is now acknowledged by statute law. In Ohio the statute declares that "a person of *pure white* blood, who intermarries with any negro, or person having a distinct and visible admixture of African blood, and any negro or person having a distinct and visible admixture of African blood, who intermarries with any person of *pure white* blood, shall be fined not more than one hundred dollars, or imprisoned not more than three months, or both." And the judge who knowingly issues the license and the person who knowingly solemnizes the marriage are subject to the same penalties. It is possible, however, on the common-law principle, that a marriage of this kind, followed by the parties living together as man and wife, would be held valid, though they would be subject to the penalties of the law. But in a number of other States—mostly

Southern—such a marriage is declared absolutely void, and the parties living together under it are punishable by imprisonment in the penitentiary for "lascivious cohabitation." In these States the international and interstate rule, that a marriage legally contracted in one State is valid in every other State, is outraged and defied; and parties lawfully married in a State which does not prohibit the intermarriage of white and colored persons removing into these States are not recognized as husband and wife, but are made subjects of a law punishing fornication and adultery.

Before emancipation there was no legal marriage between slaves—a slave not being competent to enter into a contract—so that the relation of husband and wife depended wholly upon the will and caprice of the master. And the children of such marriages were neither legitimate nor illegitimate, coming into the world independent of all marriage laws. For this reason it would have been illogical in those States to have made it a penal offense for a white man and a slave woman, either through love, lustful passion, or desire of increase of property, to beget children of mixed white and colored blood, though the large numbers of persons of mixed color in the Southern States show that it was practiced to a profitable degree. But since the conditions of slavery have ceased to exist, and the freedmen have become citizens of the United States, endowed by the Constitution with all the political and civil rights enjoyed by their former masters, including the natural right of marriage, the reasons upon which the former black laws were based can have no application to the present social rights of these people. Still, the prejudice, deeply rooted in the interest of slavery, exists; and the cases recently before the Supreme Court under the civil-rights law, to test the constitutionality of the State laws punishing marriage between white and colored persons, have been decided on collateral issues in favor of that prejudice. Thus the laws of several States and the ruling of the highest tribunal in the land interrupt the natural law of selection and development. But the question is not at rest; it must be met—met as it now is, and as it will appear in the future. And if those States and the courts will not respond to the demands of the higher civilization of the age which recognizes this fundamental social law, Congress should clearly recognize and define the equal married rights of the citizens of the United States in the District of Columbia and the Territories, without regard to "race, color, or previous condition of servitude."

According to the last census, the population of the United States is reported at fifty millions, in round numbers. The report is very exact in giving the age, sex, and place of birth of each individual, native and foreign, and much other information valuable to the student of ethnology and the migration of peoples. But it is neglectful of one of the most important questions of races. It divides the population into two races, "white" and "colored," giving the number of the former at over forty-three millions, and the number of the latter at over six millions; and, in every reference to the distribution of population for causes, it fails to distinguish between the black negro and colored white, but includes them as one. It fails to tell how many of the six millions of "colored" are of pure negro blood, how many are mulattoes, quadroons, octoroons, or of a less degree than pure white. It fails to tell how many of the mixed blood are of pure white fathers, or pure white mothers—information necessary for the prediction of the future progress, endurance, and social position of the "colored race." This neglect, both in the last and preceding census reports, if not willful, is not creditable to the science side of our Government.

Before the war, citizenship was qualified by the word "white" in the Constitutions of the several States, but there was no uniformity in the definition of the word. Some States held that a person who had more white blood than black blood in his veins was white within the meaning of their Constitutions. Other States held that a person who had less than three fourths or seven eighths of white blood was black, and still other States held that anything less than pure white was black. But since the adoption of the fourteenth amendment, which declares that "all persons born or naturalized in the United States are citizens of the United States and the State in which they reside," and that "no State shall make or enforce any law which shall abridge the privileges or immunities of citizens of the United States," this qualification of citizenship by the word "white" has no application, so far as the civil and political rights of the citizen are concerned. Nevertheless, wherever the law affects the social or semi-social relations of the citizen, his rights are qualified, and the word white excludes from the equal privileges and protection of the law all citizens having the least particle of colored blood in their veins. In one of the recent civil-rights cases decided by the Supreme Court—a case of the marriage of a white woman with a colored man—the court held that the State law punishing the parties was not in conflict with the fourteenth amendment, or with the civil-rights law founded on it, for the reason that the State law applies the same punishment to both offenders, the white and the black, without distinction! True, the punishment was equal without distinction of color, as it would have been in a case of larceny. But the law in prohibiting the marriage could not be constitutional, because it abridges the privileges of the citizen on account of color; it denies to the colored male citizen the equal privilege and protection of the law extended to the white male citizen—the right to marry a white woman. It also denies the white female citizen the equal privilege and protection of the law granted the colored female citizen—the right to marry a colored man.

However much the prejudice of the law and the courts may give an enforced unity to the negro race and the "colored whites," there is no ignoring the physical fact that a person who is seven eighths white, or who is but one thirty-second part colored, is not black. Of the six millions of blacks, "black" according to the United States census and the decisions of the courts, perhaps nearly two millions are of a mixed color, more white than black. Many of them are descendants of the most distinguished white blood in the history of the nation. To what race do they belong? By State laws and the decision of the Supreme Court they belong to the negro or the American-African race. By the law of nature they belong, either to the Anglo-American race, or are a race within themselves. It is no longer a doubtful question; their constant increase in numbers shows that they are engenesic, and capable of maintaining within themselves a race of their own. Can such a people as this mixed race, imbued with the instincts, capabilities, and ambitions common to their white blood, be forever thrust back upon the negro race? Is the race-conflict so irrepressible in this country that they can not ever be merged in the white race? Or is it wiser for science and the law to recognize, in the process of the formation of races, that they are strictly a distinct and intermediate race? Already, in proportion to numbers, as many of them stand as high in intellectual development as white persons of the same class. And as the great mass of mankind, white and black, must ever be laborers and followers, and as all the avenues of trade and commerce, learning, culture, and civil and political distinctions, are open to all, this "mixed race" must eventually become sharp competitors for the supremacy in this country. What the result may be to this republic is a problem for the publicist, the scientist, and the statesman to solve.

EVOLUTION.

By H. H. BOYESEN.

I.

BROAD were the bases of all being laid
On pillars sunk in the unfathomed deep
Of universal void and primal sleep.
Some mighty will there was, in sooth, that swayed
The misty atoms which inhabited
The barren, unillumined fields of space;
A breath, perchance, that whirled the mists apace,
And shook the heavy indolence that weighed
Upon the moveless vapors. Oh, what vast,
Resounding undulations of effect
Awoke that breath! What dizzying æons passed
Ere yet a lichen-patch the bare rock flecked!
Thus rolls with boom of elemental strife
The ancestry e'en of the meanest life.

II.

I am the child of earth and air and sea!
My lullaby by hoarse Silurian storms
Was chanted; and through endless changing forms
Of plant and bird and beast unceasingly
The toiling ages wrought to fashion me.
Lo, these large ancestors have left a breath
Of their strong souls in mine, defying death
And change. I grow and blossom as the tree,
And ever feel the deep-delving earthy roots
Binding me daily to the common clay.
But with its airy impulse upward shoots
My life into the realms of light and day;
And thou, O Sea, stern mother of my soul,
Thy tempests sing in me, thy billows roll!

III.

A sacred kinship I would not forego
Binds me to all that breathes; through endless strife
The calm and deathless dignity of life
Unites each bleeding victim to its foe.
What life is in its essence, who doth know?
The iron chain that all creation girds
Encompassing myself and beasts and birds,
Forges its bond unceasing from below—
From water, stone, and plant, e'en unto man.
Within the rose a pulse that answered mine
(Though hushed and silently its life-tide ran)
I oft have felt; but when with joy divine
I hear the song-thrush warbling in my brain,
I glory in this vast creation's chain.

IV.

I stood and gazed with wonder blent with awe
Upon the giant footprints Nature left
Of her primeval march in yonder cleft;
A fern-leaf's airy woof, a reptile's claw,
In their eternal slumber there I saw
In deftly-wrought sarcophagi of stone.
What humid tempests, from rank forests blown,
Whirled from its parent stem yon slender straw?
What scaly creature of a monstrous breed
Bore yonder web-foot through the tepid tide?
Oh, what wide vistas thronged with mighty deed
And mightier thought have here mine eyes descried!—

Come, a fraternal grasp, thou hand of stone!
The flesh that once was thine is now mine own.

V.

Sublime is life, though in beginnings base
At first enkindled. In this clod of mold
Beats with faint spirit-pulse the heart of gold
That warms the lily's cheek; its silent grace
Dwells unborn 'neath this sod. Fain would I trace
The potent mystery which, like Midas' hand,
Thrills the mean clay into refulgence grand;
For, gazing down the misty aisles of space
And time, upon my sight vast visions throng
Of the imperial destiny of man.
The life that throbbed in plant and beast ere long
Will break still wider orbits in its van—
A race of peace-robed conquerors and kings,
Achieving evermore diviner things.

—From "Idyls of Norway."

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THE BOUNDARIES OF ASTRONOMY.

II.

THE NEBULAR HYPOTHESIS.

By ROBERT S. BALL, F.R.S.,
ASTRONOMER-ROYAL OF IRELAND.

THE whole range of astronomy presents no speculations which have attracted more attention than the celebrated nebular hypotheses of Herschel and of Laplace. We shall first enunciate these speculations, and then we shall attempt to indicate how far they seem to be warranted by the actual state of scientific knowledge. In one of his most memorable papers, Sir William Herschel presents us with a summary of his observations on the nebulæ, arranged in such a manner as to suggest his theory of the gradual transmutation of nebulæ into stars. He first shows us that there are regions in the heavens where a faint diffused nebulosity is all that can be detected by the telescope. There are other nebulæ in which a nucleus can be just discerned; others again in which the nucleus is easily seen; and still others where the nucleus is a brilliant, star-like point. The transition from an object of this kind to a nebulous star is very natural, while the nebulous stars pass into the ordinary stars by a few graduated stages. It is thus possible to enumerate a series of objects, beginning at one end with the most diffused nebulosity, and ending at the other with an ordinary fixed star or group of stars. Each object in the series differs but slightly from the object just before it and just after it. It seemed to Herschel that he was thus able to view the actual changes by which masses of phosphorescent or glowing vapor became actually condensed down into stars. The condensation of a nebula could be followed in the same manner as we can study the growth of the trees in a forest by comparing the trees of various ages which the forest contains at the same time. In attempting to pronounce upon the positive evidence available in the discussion of Herschel's theory, we encounter a well-known difficulty. To establish this theory, it would be necessary to watch the actual condensation of one single nebula from the primitive gaseous condition down to the stellar points. It may easily be conceived that such a process would require a vast lapse of time, perhaps enormously greater than the period between the invention of the telescope and the present moment. It may at all events be confidently asserted that the condensation of a nebula into a star is a process which has never been witnessed. Whether any stages in that process can be said to have been witnessed is a different matter, on which it is not easy to speak with precision. Drawings of the same nebula, made at different dates, often exhibit great discrepancies. In comparing these drawings, it must be remembered that a nebula is an object usually devoid of distinct outline, and varying greatly in appearance with different telescopic apertures. Take, for instance, the very splendid nebula in Orion, which is one of the most glorious objects that can be seen in a telescope. There can be no doubt that the drawings made at different times do exhibit most marked differences. Indeed, the differences are sometimes so great that it is hard to believe that the same object is depicted. It is well to look also at drawings made of the same object at the same time, but by different observers and with different telescopes. Where we find contemporary drawings at variance—and they are often widely at variance—it seems hard to draw any conclusion from drawings as to the presence or the absence of change in the shape of the nebula.

There are, however, good grounds for believing that nebulæ really do undergo some changes, at least as regards brightness; but whether these changes are such as Herschel's theory would seem to require is quite another question. Perhaps the best authenticated instance is that of the variable nebula in the constellation of Taurus, discovered by Mr. Hind in 1852. At the time of its discovery this object was a small nebula about one minute in diameter, with a central condensation of light. D'Arrest, the distinguished astronomer of Copenhagen, found, in 1861, that this nebula had vanished. On the 29th of December, 1861, the nebula was again seen in the powerful refractor at Pulkova, but, on December 12, 1863, Mr. Hind failed to detect the nebula with the telescope by which it had been originally discovered. This instrument had, however, only half the aperture of the Pulkova telescope. In 1868, O. Struve, observing at Pulkova, detected another nebulous spot in the vicinity of the place of the missing object, but this has also now vanished. Struve does not, however, consider that the nebula of 1868 is distinct from Hind's nebula, but he says:

> What I see is certainly the variable nebula itself, only in altered brightness and spread over a larger space. Some traces of nebulosity are still to be seen exactly on the spot where Hind and D'Arrest placed the variable nebula. It is a remarkable circumstance that this nebula is in the vicinity of a variable star, which changes somewhat irregularly from the ninth to the twelfth magnitude. At the time of the discovery, in 1861, both the star and the nebula were brighter than they have since become.

This is the best authenticated history of observed change in any nebula. It must be admitted that the changes are such as would not be expected if Herschel's theory were universally true.

Another remarkable occurrence in modern astronomy may be cited as having some bearing on the question as to the actual evidence for or against Herschel's theory. On November 24, 1876, Dr. Schmidt noticed a new star of the third magnitude, in the constellation Cygnus. The discoverer was confident that no corresponding object existed on the evening of the 20th of November. The brilliancy of the new star gradually declined, until, on the 13th of December, Mr. Hind found it of the sixth magnitude. The spectrum of this star was carefully studied by many observers, and it exhibited several bright lines, which indicated that the star differed from other stars by the possession of vast masses of glowing gaseous material. This star was observed by Dr. Copeland, at the Earl of Crawford's observatory, on September 2, 1877. It was then below the tenth magnitude, and of a decidedly bluish tint. Viewed through the spectroscope, the light of this star was almost completely monochromatic, and appeared to be indistinguishable from that which is often found to come from nebulæ. Dr. Copeland thus concludes:

> Bearing in mind the history of this star from the time of its discovery by Schmidt, it would seem certain that we have an instance before us in which a star has changed into a planetary nebula of small angular diameter. At least it may be safely affirmed that no astronomer, discovering the object in its present state, would, after viewing it through a prism, hesitate to pronounce as to its present nebulous character.

It should, however, be added that Professor Pickering has since found slight traces of a continuous spectrum, but the object has now become so extremely faint that such observations are very difficult. This remarkable history might be adduced if we wished to procure evidence of the conversion of stars into nebulæ, but for the nebular theory we require evidence of the conversion of nebulæ into stars.

Care must be taken not to exaggerate the inferences to be drawn from the two instances I have quoted, viz., the variable nebula in Taurus and the new star in Cygnus. I think it more likely that both of these are to be regarded as exceptional phenomena. It is certainly true that they are perhaps the most remarkable instances in which changes in nebulæ have actually been witnessed; but the probability is that the only reason why they have been witnessed is because they were very exceptional. Those who have observed the nebulæ for many years are well assured of the general permanence of their appearance. The nebulæ we have referred to are chosen out of thousands. The ordinary nebulæ appear just as constant as the ordinary bright stars. Every one expects to see Vega in the constellation Lyra; and with equal confidence every astronomer counts on seeing the celebrated annular nebula when he directs his telescope to the same constellation. This permanence is very probably merely due to the stupendous distances at which these objects are placed. Only gigantic changes could be detected, and for these, gigantic periods of time would be required. We are bound to believe that heated bodies radiate their heat; and, if so, they must contract. This general law, which pervades all Nature, so far as we know it, seems to be the real basis—indeed, the only basis—on which the nebular theory of Herschel can be maintained. Up to the present, it must be admitted that this theory has received no direct telescopic confirmation.

The nebular theory by which Laplace sought to account for the origin of the solar system seems, from the nature of the case, to be almost incapable of receiving any direct testimony. We shall here enunciate the theory in the language of Professor Newcomb:

> The remarkable uniformity among the directions of the revolutions of the planets being something which could not have been the result of chance, Laplace sought to investigate its probable cause. This cause, he thought, could be nothing else than the atmosphere of the sun, which once extended so far out as to fill all the space now occupied by the planets. He conceives the immense vaporous mass forming the sun and his atmosphere to have had a slow rotation on its axis. The mass, being intensely hot, would slowly cool off, and as it did so would contract toward the center. As it contracted, its velocity would, in obedience to one of the fundamental laws of mechanics, constantly increase, so that a time would arrive when, at the outer boundary of the mass, the centrifugal force due to the rotation would counterbalance the attractive force of the central mass. Then those outer portions would be left behind as a revolving ring, while the next inner portions would continue to contract, until at their boundary the centrifugal and attractive forces would be again balanced, when a second ring would be left behind, and so on. Thus, instead of a continuous atmosphere, the sun would be surrounded by a series of concentric revolving rings of vapor.
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> Now, how would these rings of vapor behave? As they cooled off, their denser materials would condense first, and thus the ring would be composed of a mixed mass, partly solid and partly vaporous, the quantity of solid matter constantly increasing and that of vapor diminishing. If the ring were perfectly uniform this condensing process would take place equally all around it, and the ring would thus be broken up into a group of small planets like that which we see between Mars and Jupiter. But we should expect that, in general, some

portions of the ring would be much denser than others, and the denser portion would gradually attract the rarer portions around it, until instead of a ring we should have a single mass, composed of a nearly solid center, surrounded by an immense atmosphere of fiery vapor. This condensation of the ring of vapor around a single point would have produced no change in the amount of rotary motion originally existing in the ring; the planet surrounded by its fiery atmosphere would therefore be in rotation, and would be, in miniature, a reproduction of the case of the sun surrounded by his atmosphere with which we set out. In the same way that the solar atmosphere formed itself first into rings, and then these rings condensed into planets, so, if the planetary atmosphere were sufficiently extensive, they would form themselves into rings, and these rings would condense into satellites. In the case of Saturn, however, one of the rings was so perfectly uniform that there could be no denser portion to draw the rest of the ring around it, and thus we have the well-known rings of Saturn.

It will thus be seen that one of the principal features in the solar system for which the nebular theory has been invoked is the fact that the planets all revolve round the sun in the same direction. It will therefore be natural to take up first the discussion of this subject, and to inquire how far the common motion of the planets can be claimed in support of Laplace's nebular theory. The value of this argument is very materially influenced by another consideration of a somewhat peculiar character. If it were quite immaterial to the welfare of the planetary system whether all the planets moved the same way, or whether some moved one way and some another, then the nebular hypothesis would be entitled to all the support which could be derived from the circumstances of the case. Take, for instance, the eight principal planets—Mercury, Venus, the Earth, Mars, Jupiter, Saturn, Uranus, Neptune. All these planets move in the same way around the sun. The chances against such an occurrence are 127 to 1. The probability that the system of eight planets have been guided to move in the same direction by some cause may be taken to be 127 to 1. If we include the two hundred minor planets, the probability would be enormously enhanced. The nebular theory seems a reasonable explanation of how this uniformity of movements could arise, and therefore the advocates of the nebular theory may seem entitled to claim all this high degree of probability in their favor. There is, however, quite a different point of view from which the question may be regarded. There are reasons which imperatively demand that the planets (at all events the large planets) shall revolve in uniform directions, which lie quite outside the view taken in the nebular theory. If the big planets did not all revolve in the same direction, the system would have perished long ago, and we should not now be here to discuss the nebular or any other hypothesis.

It is well known that, in consequence of the gravitation which pervades the solar system, each of the planets has its movements mainly subordinated to the attraction of the sun. But each of the planets attracts every other planet. In consequence of these attractions the orbits of the planets are to some extent affected. The mutual actions of the planets present many problems of the highest interest, and, it should be added, of the greatest difficulty. Many of these difficulties have been overcome. It is the great glory of the French mathematicians to have invented the methods by which the nature of the solar system could be studied. The results at which they arrived are not a little remarkable. They have computed how much the planets act and react upon each other, and they have shown that in consequence of these actions the orbit of each planet gradually changes its shape and its position. But the crowning feature of these discoveries is the demonstration that these changes in the orbits of the planets are all periodic. The orbits may fluctuate, but those fluctuations are confined within very narrow limits. In the course of ages the system gradually becomes deformed, but it will gradually return again to its original position, and again depart therefrom. These changes are comparatively so small that our system may be regarded as substantially the same even when its fluctuations have attained their greatest amplitude. These splendid discoveries are founded upon the actual circumstances of the system, as we see that system to be constituted. Take, for instance, the eccentricities of the orbits of the planets around the sun. Those eccentricities can never change much; they are now small quantities, and small quantities those eccentricities must forever remain. The proof of this remarkable theorem partly depends upon the fact that the planets are all revolving around the sun in the same direction. If one of the planets we have named were revolving in an opposite direction to the rest, the mathematical theory would break down. We would have no guarantee that the eccentricities would forever remain small as they are at present. In a similar manner, the planets all move in orbits whose planes are inclined to each other at very small angles. The positions of those planes fluctuate, but these fluctuations are confined within very narrow limits. The proof of this theorem, like the proof of the corresponding theorem about the eccentricities, depends upon the actual conditions of the planetary system as we find it. If one of the planets were to be stopped, turned round, and started off again in the opposite direction, our guarantee for the preservation of the planes would be gone. It therefore follows that, if the system is to be permanently maintained, all the planets must revolve in the same direction.

In this connection it is impossible not to notice the peculiar circumstances presented by the comets. By a sort of convention, the planets have adopted, or, at all events, they possess, movements which fulfill the conditions necessary if the planets are to live and let live; but the comets do not obey any of the conditions which are imposed by the planetary convention. The orbits of the comets are not nearly circles. They are sometimes ellipses with a very high degree of eccentricity; they are often so very eccentric that we are unable to distinguish the parts of their orbits which we see from actual parabolas. Nor do the directions in which the comets move exhibit any uniformity ; some move round the sun in one direction, some move in the opposite direction. Even the planes which contain the orbits of the comets are totally different from each other. Instead of being inclined at only a very few degrees to their mean position, the planes of the comets hardly follow any common law ; they are inclined at all sorts of directions. In no respect do the comets obey those principles which are necessary to prevent constitutional disorder in the planetary system. The consequences of this are obvious, and unfortunate in the highest degree—for the comets. A comet possesses no security for the undisturbed enjoyment of its orbit. Not to mention the risk of actual collision with the planets, there are other ways in which the path of a comet may experience enormously great changes by the disturbances which the planets are capable of producing. How is it that the system has been able to tolerate the vagaries of comets for so many ages ? Solely because the comets, though capable of suffering from perturbations, are practically incapable of producing any perturbations on the planets. The efficiency of a body in producing perturbations depends upon the mass of the body. Now, all we have hitherto seen with regard to comets tends to show that the masses of comets are extremely small. Attempts have been made to measure the masses of comets. Those attempts have always failed. They have failed because the scales in which we have attempted to weigh the comets have been too coarse to weigh anything of the almost spiritual texture of a comet. It is unnecessary to go as far as some have done, and to say that the weight of a large comet may be only a few pounds or a few ounces. It might be more reasonable to suppose that the weight of a large comet was thousands of tons, though even thousands of tons would be far too small a weight to admit of being measured by the very coarse balance which is at our disposal.

The enduring stability of the planetary system is thus seen to be compatible with the existence of comets solely because comets fulfill the condition of being almost imponderable in comparison with the mighty masses of the planetary system. The very existence of our planetary system is a proof of the doctrine that the masses of the comets are but small. Indeed, to those who will duly weigh the matter, it will probably appear that this negative evidence as to the mass of the comets is more satisfactory than the results of any of the more direct attempts to place the comets in the weighing-scales. If we restate the circumstances of the solar system, and if we include the comets in our view, it will appear how seriously the existence of the comets affects the validity of the argument in favor of the nebular hypothesis which is derived from the uniformity in the directions of the planetary movements. If we include the whole host of minor planets, we have for the population of the solar system something under three hundred planets, and an enormous multitude of comets. It will probably not be an overestimate if we suppose that the comets are ten times as numerous as the planets. The case, then, stands thus: The solar system consists of some thousands of different bodies; these bodies move in orbits of the most varied degrees of eccentricity; they have no common direction; their planes are situated in all conceivable positions, save only that each of these planes must pass through the sun. Stated in this way, the present condition of the solar system is surely no argument for the nebular theory. It might rather be said that it is inconceivable on the nebular theory how a system of this form could be constructed at all. Nine tenths of the bodies in the solar system do not exhibit movements which would suggest that they were produced from a nebula: the remaining tenth do no doubt exhibit movements which seem to admit of explanation by the nebular theory; but, had that tenth not obeyed the group of laws referred to, they would not now be there to tell the tale. The planetary system now lives solely because it was an organism fitted for survival. It is often alleged that the comets are not indigenous to the solar system. It has been supposed that the comets have been imported from other systems. It has also been urged with considerable probability that perhaps many comets may have had their origin in our sun and have been actually ejected therefrom. I do not now attempt to enter into the discussion of these views, which are at present problematical; let me pass from this part of the subject, with the remark that, until the nature and origin of comets be better understood, it will be impossible to appraise with accuracy the value of the argument for the nebular hypothesis which has been based on the uniformity of the directions in which the planets revolve around the sun.

There are, however, other circumstances in the solar system which admit of explanation by the nebular theory. It is a remarkable fact that the Earth, Mars, Jupiter, and Saturn are all known to rotate upon their axes in the same direction as their revolutions around the sun. The nebular theory offers an explanation of this circumstance. It does not appear that this common rotation of the planets is absolutely necessary for the stability of the system. Should it further be proved that there is no other agency at work which would force the planets to rotate in the same direction, then it must be admitted that the nebular theory receives very substantial support.

There is another way in which we can examine the evidence on behalf of the nebular hypothesis. There are certain actions going on at present in the solar system; and by reasoning backward from these present actions we are led to believe that in extremely early times the condition of things may have resembled that which is supposed by the nebular hypothesis. Let us begin with the consideration of our sun, which is, as we know, daily radiating off light and heat into space. This heat is poured off in all directions; a small portion of it is intercepted by the earth, but this portion is less than one two-thousand-millionth part of the whole; the planets also, no doubt, each intercept a small portion of the solar radiation; but the great mass of radiated heat from the sun entirely escapes. This heat is supposed not to be restored to the sun. The sun certainly must receive some heat by the radiation from the stars; but this is quite infinitesimal in comparison with the stupendous radiation from the sun. We therefore conclude that the sun's heat is being squandered with prodigal liberality.* We also know that the store of heat which the sun can possess, though no doubt enormously great, is still limited in amount. It is, indeed, a question of very great interest to decide what are the probable sources by which the sun is able to maintain its present rate of expenditure. The sun must have some source of heat in addition to that which it would possess in virtue of its temperature as an incandescent body. If we suppose the sun to be a vast incandescent body, formed of materials which possess the same specific heat as the materials of which our earth is composed, the sun would then cool at the rate of from 5° to 10° per annum. At this rate the sun could not have lasted for more than a few thousand years before it cooled down. We are therefore compelled to inquire whether the sun may not have some other source of heat to supply its radiation beyond that which arises merely from the temperature.

Of the various sources which have been suggested, it will here only be necessary to mention two. It has been supposed that the heat of the sun may be recruited by the incessant falling of meteoric matter upon the sun's surface. If that matter had been drawn only by the sun's attraction from the remote depths of space, it would fall upon the sun with an enormously great velocity, amounting to about 300 miles a second. It follows from the principle of the equivalence between heat and mechanical energy that a body entering the sun with this velocity would contribute to the sun a considerable quantity of heat. It is known that small meteoroids abound in the solar system; they are constantly seen in the form of shooting-stars when they dash into our atmosphere, and it can hardly be doubted that myriads of such bodies must fall into the sun. It does not, however, seem likely that enough matter of this kind can enter the sun to account for its mighty radiation of heat. It can be shown that the quantity of matter necessary for this purpose is so large that a mass equal in the aggregate to the mass of the earth would have to fall into the sun every century if the radiation of the sun were to be defrayed from this source. That so large a stream of matter should be perennially drawn into the sun is, to say the least, highly improbable. But it is quite possible to account for the radiation of the sun on strictly scientific principles, even if we discard entirely the contributions due to meteoric matter. As the sun parts with its heat it must contract, in virtue of the general law that all bodies contract when cooling; but in the act of contraction an amount of heat is produced. By this the process of cooling is greatly retarded. It can, indeed, be shown that, if the sun contracts so that his diameter decreases one mile every twenty-five years, the amount of heat necessary to supply his radiation would be amply accounted for. At this rate many thousands of years must elapse before the diminution in the sun's diameter would be large enough to be appreciable by our measurements.

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* A remarkable theory has recently been put forward by Dr. Siemens, according to which the sun's radiant energy is ultimately restored to the sun. Even the possibility of some such theory being true most seriously affects the above arguments in favor of the nebular hypothesis.

Looking back into the remote ages, we thus see that the sun was larger and larger the further back we project our view. If we go sufficiently far back, we seem to come to a time when the sun, in a more or less completely gaseous state, filled up the whole solar system out to the orbit of Mercury, or earlier still, out to the orbit of the remotest planet. If we admit that the present laws of Nature have been acting during the past ages to which we refer, then it does not seem possible to escape the conclusion that the sun was once a nebulous mass of gas such as the nebular theory of Laplace would require.

It will also throw some light upon this retrospective argument for the nebular theory if we briefly consider the probable past history of the earth. It is known that the interior of the earth is hotter than the exterior. It has been suggested that this interior heat may arise from certain chemical actions which are at present going on. If this were universally the case, the argument now to be brought forward could not be entertained. I believe, however, most physicists will agree in thinking that the interior heat of the earth is an indication that the earth is cooling down from some former condition in which it was hotter than it is at present. The surface has cooled already, and the interior is cooling as quickly as the badly conducting materials of the earth will permit. We are thus led to think of the earth as having been hotter in past time than at present. The further we look back the greater must the earth's heat have been. We can not stop till the earth was once red-hot or white-hot, till it was molten or a mass of fiery vapor. Here, again, we are led to a condition of things which would certainly seem to harmonize with the doctrines of the nebular theory.

The verdict of science on the whole subject can not be expressed better than in the words of Newcomb:

> At the present time we can only say that the nebular hypothesis is indicated by the general tendencies of the laws of Nature; that it has not been proved to be inconsistent with any fact; that it is almost a necessary consequence of the only theory by which we can account for the origin and conservation of the sun's heat; but that it rests on the assumption that this conservation is to be explained by the laws of Nature as we now see them in operation.

Should any one be skeptical as to the sufficiency of these laws to account for the present state of things, science can furnish no evidence strong enough to overthrow his doubts until the sun shall be found growing smaller by actual measurement, or the nebulæ be actually seen to condense into stars and systems.

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DARWIN AND COPERNICUS.*

By Professor E. DU BOIS-REYMOND.

THE losses by death which natural science has sustained during the past year are unusually heavy. The fertile and ingenious mathematician who for more than a generation held a leading position among French men of science as the publisher of one of the best-known mathematical journals ; the chemist who, by the first organic synthesis, helped to dispel the illusion of vital energy ; the physiologist who solved one of the oldest problems of humanity—are men whose death leaves a void not easily filled up. But the luster of even such names as Liouville, Wöhler, and Bischoff pales before that of the first on our list, Charles Darwin. Nearly every learned society in existence has publicly deplored his loss. As this Academy has not hitherto found a fitting opportunity for doing so, it is necessary to add a few words to the formal mention of his decease, to show that we also appreciate the greatness of the man and of the loss science has sustained in him.

To say anything fresh concerning him will only be possible when the lapse of time and the progress of science have opened up new points of view ; and the speaker, who has often had occasion to discuss Darwin before this Academy, finds it especially difficult not to repeat himself, the more so as opinions of his work are still somewhat apt to be influenced by personal feeling.

Darwin seems to me to be the Copernicus of the organic world. In the sixteenth century Copernicus put an end to the anthropocentric theory by doing away with the Ptolemaic spheres and bringing our earth down to the rank of an insignificant planet. At the same time he proved the non-existence of the so-called empyrean, the supposed abode of the heavenly hosts, beyond the seventh sphere, although Giordano Bruno was the first who actually drew the inference.

Man, however, still stood apart from the rest of animated beings—not at the top of the scale, his proper place, but quite away, as a being absolutely incommensurable with them. One hundred years later Descartes still held that man alone had a soul, and that beasts were mere automata. Notwithstanding all the labor of naturalists since the days of Linnæus, notwithstanding the resurrection of vanished genera and species by Cuvier, the theory of the origin and interdependence of

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*** Address delivered at the anniversary meeting of the Berlin Academy of Sciences.**

living things, which was almost universal five-and-twenty years ago, was only equaled in arbitrariness, artificiality, and absurdity by the celebrated theory of Epicycles, which caused Alfonso of Castile to exclaim, "If God had asked my advice when he created the world, I should have managed things much better."

"*Afflavit Darwinius et dissipata est,*" would, alluding to the above-mentioned theory, be a fitting inscription for a medal in honor of the "Origin of Species." For now all things were seen to be due to the quiet development of a few simple germs; graduated days of creation gave place to one day on which matter in motion was created; and organic suitability was replaced by a mechanical process, for as such we may look on natural selection, and now for the first time man took his proper place at the head of his brethren.

We may compare Copernicus's student-days at Bologna with Darwin's voyage in the Beagle, and his retired life at Frauenburg with Darwin's in his Kentish home, up to the time when the appearance of Mr. Wallace's work caused him to break his long silence. Here, happily for Darwin, the parallel ends. Many circumstances combined in Darwin's case to render his task easier and insure his ultimate triumph. Botany and zoölogy, morphology, the theory of evolution, and the study of the geographical distribution of plants and animals, had advanced far enough to allow of general conclusions being drawn from them; Lyell's sound sense had freed geology from the hypotheses which disfigured it, and introduced the idea of uniformity into science. The doctrine of the conservation of energy had been put on a new basis, and extended so that in combination with astronomical observation it gave rise to entirely new views of the history and duration of the universe. The doctrine of vital energy had been proved to be untenable on closer investigation. An unusually dry season had some years earlier led to the discovery of the so-called lake-dwellings in the bed of one of the Swiss lakes, whereby prehistoric research was quickly extended and developed. Though many links are still missing, we may fairly consider the knowledge of the existence of primeval man as the beginning of the long-looked-for connection between him and the anthropoids on the one hand, and between them both and their common progenitors on the other. In a word, the time had come for the publication of the "Descent of Man"; that is why an opinion on the nature of man, which differs from all former ones fully as much as the system of Copernicus, of which it is the complement, differs from that of Ptolemy, found such ready and general acceptance.

How different was the fate of Copernicus! "Copernicus," says Poggendorff, "is, and will ever remain, a brilliant star in the firmament of science; but he rose at a time when the horizon was almost entirely obscured by the mists of ignorance. . . . The Ptolemaic system was too ancient and too much venerated to be easily displaced." Copernicus's teaching met with but scant appreciation for the first fifty years after its publication; even Tycho Brahe opposed it; it can therefore scarcely cause surprise that Luther rejected it, that Giordano Bruno died at the stake for his advocacy of it, while the less steadfast Galileo was forced to renounce it.

Notwithstanding the pessimism of our speculative philosophers, who deny all progress because they contribute nothing toward it, Darwin's lot was happier than that of the great reformer of astronomy. While Copernicus could only feast his eyes on the first printed copy of his work as he lay on his death-bed, because he had not dared to publish it sooner, although he had completed it some years before, Darwin survived the appearance of his nearly a quarter of a century. He witnessed the fierce struggles its appearance at first gave rise to; its ever-increasing acceptance and its final triumph, to which he, cheerful and active to the last, greatly contributed by a long series of admirable works.

While the Holy Inquisition persecuted the followers of Copernicus with fire and sword, Charles Darwin lies buried in Westminster Abbey among his peers, Newton and Faraday.

WHISTLING.

BY T. F. THISELTON DYER.

IN whatever way regarded, either as a graceful accomplishment or as the spontaneous expression of light-heartedness, whistling has in our own and foreign countries generally attracted considerable attention. Why it should have been invested with so much superstitious awe it is difficult to say, but it is a curious fact that the same antipathy which it arouses among certain classes of our own countrymen is found existing in the most distant parts of the earth, where, as yet, civilization has made little or imperceptible progress. Thus Captain Burton* tells us how the Arabs dislike to hear a person whistle, called by them *el sifr*. Some maintain that the whistler's mouth is not to be purified for forty days; while, according to the explanation of others, Satan touching a man's body causes him to produce, what they consider, an offensive sound† The natives of the Tonga Islands, Polynesia, hold it to be wrong to whistle, as this act is thought to be disrespectful to God.‡ In Iceland, the villagers have the same objection to whistling, and so far do they carry their superstitious dread of it that "if one swings about him a stick, whip, wand, or aught that makes a whistling sound, he scares from him the Holy Ghost"; while other Icelanders, who consider themselves free from superstitions, cautiously give the advice: "Do it not; for who knoweth what is in the air?" However eccentric these phases of superstitious belief may appear to us, yet it must not be forgotten that very similar notions prevail at the present day, in this country. A correspondent of "Notes and Queries" (1879, fifth series, xii, 92), for instance, relates how one day, after attempting in vain to get his dog to obey orders to come into the house, his wife tried to coax it by whistling, when she was suddenly interrupted by a servant, a Roman Catholic, who exclaimed in the most piteous accents, "If you please, ma'am, don't whistle—every time a woman whistles, the heart of the blessed Virgin bleeds!" In some districts of North Germany the villagers say that if one whistles in the evening it makes the angels weep. Speaking, however, of ladies in connection with whistling, it is a wide-spread superstition that it is at all times unlucky for them to whistle, which, according to one legend, originated in the circumstance that, while the nails for our Lord's cross were being forged, a woman stood by and whistled. Curiously enough, however, one very seldom hears any of the fair sex indulging in this recreation, although there is no reason, as it has been often pointed out, why they should not whistle with as much facility as the opposite sex. One cause, perhaps, of the absence of this custom among women may be, in a measure, due to the distortion of the features which it occasions. Thus we know how Minerva cast away, with an imprecation, the pipe, which afterward proved so fatal to Marsyas, when she beheld in the water the disfigurement of her face caused by her musical performance. There are numerous instances on record, nevertheless, of ladies whistling at public entertainments, and charming their audiences with the graceful ease with which they performed such airs as "The Blue Bells of Scotland" or "The Mocking-Bird." Indeed, not many years ago, at a grand provincial concert, two sisters excited much admiration by the clever and artistic way in which they whistled a duet.

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* "First Footsteps in East Africa," 1856, p. 142.

† Carl Engel, "Musical Myths and Facts," 1876, i, 91.

‡ "Mariner and Martin: An Account of the Natives of the Tonga Islands," 1818, ii, 131.

Referring to whistling performances, Addison, in one of the earlier numbers of the "Spectator," gives an amusing account of a contest, where a prize of a guinea was to be conferred on the successful competitor who could not only whistle the best, but go through his tune without laughing, and that in spite of the ludicrous antics of a certain merry-andrew, whose special duty it was to try as far as possible to discompose each of the competitors by making grimaces. On the occasion in question, the competitors were an under-citizen, remarkable for his wisdom—a plowman endued "with a very promising aspect of inflexible stupidity"—and a footman, who, having captivated his audience by whistling "a Scotch tune and an Italian sonata," carried off the prize. Strutt, in his "Sports and Pastimes," relates the remarkable performance of a whistler, who, assuming the name of Rossignol, exhibited at the end of the last century his talent on the stage of Covent Garden Theatre, and attracted for some time considerable notice.*

Anyhow, the universality of the prejudice against women whistling is an acknowledged fact, and there are few localities where one may not hear the familiar rhyme :

"A whistling wife and a crowing hen
Will call the old gentleman out of his den."

Of course there are various versions, as, for instance, in Northamptonshire, where the peasantry say :

"A whistling woman and a crowing hen
Are neither fit for God nor men."

The Cornish saying is to the same effect : "A whistling woman and a crowing hen are the two unluckiest things under the sun." Similar also is the French proverb, "*Une poule qui chante le coq et une fille qui siffle portent malheur dans la maison.*" The same superstition prevails among the seafaring community ; and Mr. Henderson† relates how, a few years ago, when a party of friends were about to go on board a vessel at Scarborough, the captain caused no small astonishment by declining in the most emphatic way to allow one of them to enter it : "Not that young lady," he cried out ; "she whistles." By a curious coincidence, the vessel was lost on her next voyage ; so, had the young lady formed one of the party, the misfortune would certainly have been attributed to her. After all, it seems hard that, if the mere act of whistling can help to cheer a man, such a soothing influence should be denied to a woman. "If whistling," says a writer in the "Phrenological Journal," "will drive away the blues and be company for a lonesome person, surely women have much more need of its services than their brothers, for to them come many more such occasions than to men. There is a physical advantage in whistling which should excuse it against all the canons of propriety or 'good form.' It is often remarked that the average girl is so narrow-chested, and in that respect compares so unfavorably with her brother, which may be due in some measure to the habit of whistling which every boy acquires." An eminent medical authority says : "All the men whose business it is to try the wind-instruments made at the various factories before sending them off for sale are, without exception, free from pulmonary affections. I have known many who, when entering upon this calling, were very delicate, and who, nevertheless, though their duty obliged them to blow for hours together, enjoyed perfect health after a certain time." As the action of blowing wind-instruments is the same as that of whistling, the effects should be the same. Whistling has been popularly styled the "devil's music," the reason, in all probability, being that, when persons are up to anything wrong and likely to be caught, they assume an air of indifference by whistling. As the daily music of boys, however, it may be attributed to want of thought; and so Cowper, in his description of the "Postman" ("Task," book iv), says:

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* See an article entitled "Mouth Music" in "Book of Days," i, 751.

† "Folk-lore of the Northern Counties," 1879, p. 43.

> "He whistles as he goes, light-hearted wretch,
> Cold and yet cheerful; messenger of grief
> Perhaps to thousands, and of joy to some,
> To him indifferent whether grief or joy."

In Shield's opera of "The Farmer," the singer—"now a saucy footman"—thus reverts to his boyhood:

> "A flaxen-headed cowboy, I whistled o'er the lea,
> And then a little plowboy, as happy as could be."

Dryden, too, says in his "Cymon and Iphygenia":

> "He whistled as he went, for want of thought."

And the same idea was perhaps in Milton's mind—

> "While the plowman near at hand,
> Whistles o'er the furrowed land."

Gay, also, wrote in the same strain:

> "The plowman leaves the task of day,
> And trudging homeward, whistles on the way."

The act of "whistling in one's fist," which is much in use among the lower orders, especially when they are desirous of sending the sound some distance, consists in bringing the thumbs of both hands together, leaving the hands and closed fingers to form a hollow space; then, by blowing through the narrow aperture left between the thumbs, a very loud and shrill whistle is produced. In Lincolnshire, in my school-days, says a correspondent of "Notes and Queries" (fourth series, ii, 213), this form of whistling used to be called the "thieves' whistle"—a name, by-the-by, which is still employed in London. Indeed, few subjects have given rise to a greater variety of popular every-day sayings than whistling. Thus the expression, to "pay for one's whistle"—a favorite phrase with George Eliot—means to gratify one's fancy. Again, a thing worthy of notice is said in common parlance to be "worth the whistle"; the reference obviously being to the ordinary way of calling up a dog. Heywood, for instance, in one of his proverbs, says, "It is a poor dog that is not worth the whistling." Shakespeare, too, makes Goneril say to Albany, in "King Lear" (Act iv, scene 2):

> "I have been worth the whistle."

Then there is the phrase, "To pay too dearly for one's whistle," implying that, after a person has paid dearly for something he fancied, he finds it does not answer his expectations. The allusion, says Dr. Brewer, in his "Dictionary of Phrase and Fable," is to a story told by

Dr. Franklin of his nephew, who set his mind on a common whistle, which he bought of a boy for four times its value. Franklin says the "ambitious who dance attendant on court, the miser who gives this world and the next for gold, the libertine who ruins his health for pleasure, the girl who marries a brute for money, all in the long run pay too much for their whistle." Once more, the old hackneyed proverbs "To wet one's whistle" and "To whistle for more" allude to the whistle drinking-cups of days gone by. It appears that, in the sixteenth and seventeenth centuries, silversmiths devoted a large amount of invention to the production of drinking-tankards, which took the form of men, animals, birds, etc., of most grotesque design.* According to one popular device, the cup had to be held in the hand to be filled, and retained there till it was emptied, as then only it could be set on the table. The drinker having swallowed the contents, blew up the pipe at the side, which gave a shrill whistle, and announced to the drawer that more liquor was required. Hence, too, no doubt, originated the phrase "whistle-drunk." Fielding relates how Squire Western, when supping one night at a friend's house, "was indeed whistle-drunk," for before he had swallowed the third bottle he became so entirely overpowered that, though he was not carried off to bed till long after, the parson considered him as absent.

The idea of ghosts whistling is still far from extinct in England, and enters largely into the folk-lore of our peasantry; a superstition which has been associated with the "Seven Whistlers," supposed by some to be phantom-birds. Thus, among the colliers of Leicestershire, we are told how, when trade is brisk and money plentiful, disposing them for a drinking-frolic, they are said to hear the warning voice of the "Seven Whistlers"—birds sent purposely, as they affirm, by Providence to warn them of an impending danger, and on hearing the signal not a man will descend into the pit until the following day.† Wordsworth, it may be remembered, in one of his sonnets, couples the "Seven Whistlers" with the "Gabriel hounds," those weird, mysterious specter-dogs which with such fiendish yellings haunt the midnight air:

> "The poor old man is greater than he seems:
> He the seven birds hath seen that never part,
> Seen the seven whistlers in their nightly rounds,
> And counted them; and oftentimes will start,
> For overhead are sweeping Gabriel's hounds."

The superstitious fear attaching to these whistlers is noticed by Spenser in his "Faerie Queen" (book ii, canto xii, stanza 36), where, "among the nation of unfortunate and fatal birds" that flocked about Sir Guyon and the Palmer, it is thus alluded to:

> "The whistler shrill, that whoso hears doth die."

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* Chambers's "Book of Days," ii, 455.

† "Nature," June 22, 1871, 140; "Notes and Queries," fourth series, viii, 68.

It has been suggested that the whistler is the green plover to which Sir Walter Scott refers in "The Lady of the Lake," where he relates how—

> "In the plover's shrilly strains
> The signal whistle's heard again"—

its ominous shrill whistle which startles, with dreadful awe, the midnight traveler as he journeys along some lonely road, sounding far more like a human note than that of a bird. In illustration of this view we may quote the following anecdote related by a correspondent of "Notes and Queries" (fourth series, viii, 268), which, however, supports the popular theory of the birds in question being supernatural beings: "One evening a few years ago, when crossing one of our Lancashire moors in company with an intelligent old man, he was suddenly startled by the whistling overhead of a covey of plovers. My companion remarked that when a boy the old people considered such a circumstance a bad omen, 'as a person who heard the wandering Jews,' as he called the plovers, 'was sure to be overtaken by some ill-luck.' On questioning my friend about the name given to the birds, he said, 'There is a tradition that they contain the souls of those Jews who assisted at the crucifixion, and in consequence were doomed to float in the air forever.' When he arrived at the foot of the moor, a coach by which I had hoped to reach my destination had already started, thereby causing me to continue my journey on foot. The old man reminded me of the omen." To quote a further anecdote recorded by another correspondent of the same journal, we are told how during a thunder-storm which passed over the neighborhood of Kettering on the evening of September 6, 1871—on which occasion the lightning was very vivid—an unusual spectacle was witnessed: immense flocks of birds were flying about, uttering doleful, affrighted cries as they passed over the locality, and for hours they kept up a continual whistling like that made by sea-birds. "The following day," adds the writer, "as my servant was driving me to a neighboring village, this phenomenon of the flight of birds became the subject of conversation, and, on asking him what birds he thought they were, he told me they were what were called the 'Seven Whistlers,' and that whenever they were heard it was considered a sign of some great calamity, and that the last time he heard them was before the great Hartley Colliery explosion; he had also been told by soldiers that if they heard them they always expected a great slaughter would take place soon. Curiously enough, on taking up the newspaper on the following morning, I saw headed in large letters, 'Terrible Colliery Explosion at Wigan,' etc. This, I thought, would confirm my man's belief in the "Seven Whistlers." Among the pieces of folk-lore connected with whistling may be mentioned that of sailors whistling for a wind on a calm day; an expedient which they believe seldom fails. Thus Longfellow, in his "Golden Legend," speaks of this notion:

"Only a little hour ago,
I was whistling to St. Antonio
For a capful of wind to fill our sail,
And, instead of a breeze, he has sent a gale."

Sir Walter Scott, too ("Rokeby," ii, 11), says:

"What gales are sold on Lapland's shore!
How whistle rash bids tempests roar!"

Among the numerous anecdotes connected with whistling, it may be remembered that in the train of Anne of Denmark, when she went to Scotland with James VI, was a gigantic Dane of matchless drinking capacity. He possessed an ebony whistle which, at the beginning of a drinking-bout, he would lay on the table, and whoever was last able to blow it was by general consent considered to be the "champion of the whistle." It happened, however, that during his stay in Scotland the Dane was defeated by Sir Robert Laurie, of Maxwelton, who, after three days and three nights of hard drinking, left the Dane under the table, and "blew on the whistle his requiem shrill." The whistle remained in the family seven years, when it was won by Sir Walter Laurie, son of Sir Robert. The last person who carried it off was Alexander Ferguson, of Craig-darroch, son of "Annie Laurie," so well known. Burns has immortalized the subject in a poem entitled "The Whistle," from which we quote the following stanzas:

"I sing of a whistle, a whistle of a worth,
I sing of a whistle, the pride of the North,
Was brought to the court of our good Scottish king,
And long with this whistle all Scotland shall ring.
Old Loda, still rueing the arm of Fingal,
The god of the bottle sends down from his hall;
'This whistle's your challenge—to Scotland get o'er,
And drink them to hell, sir, or ne'er see me more!'" etc.

The Russians in the Ukraine tell a queer story about a whistling robber of olden times, who evidently was a person of gigantic proportions, for he was in the habit of sitting on nine oak-trees at once. One of the nicknames given to him was "Nightingale," on account of his extraordinary whistling powers. Should an unwary traveler come across his path, he would whistle so melodiously that his victim would quickly faint away, whereupon he stepped forward and killed him outright. At last, however, a well-known hero, by name Ilja Marometz, determined to subdue the robber, and, having shot him with an arrow, took him prisoner, carrying him off to the court of the Grand Prince Vladimir. Even there he proved dangerous, for when the grand prince, merely from curiosity, commanded him to whistle, the grand princess and all the royal children being present, the man commenced whistling in such an overpowering manner that soon Vladimir with his whole family would inevitably have been dead had not one of his brave courtiers, perceiving the danger, got up and shut the whistler's mouth.*

We must not omit to mention the celebrated "Whistling Oyster," which about forty years ago created such a sensation at the small oyster and refreshment rooms situated in Vinegar Yard, near Catherine Street, Strand. "It appears," says a writer in the "Daily Telegraph," "that about the year 1840, the proprietor of the house in question, which had then, as it has now, a great name for the superior excellence of its delicate little 'natives,' heard a strange and unusual sound proceeding from one of the tubs in which the shell-fish lay, piled in layers one over the other, placidly fattening upon oatmeal, and awaiting the inevitable advent of the remorseless knife. Mr. Pearkes, the landlord, listened, hardly at first believing his ears. There was, however, no doubt about the matter. One of the oysters was distinctly whistling, or, at any rate, producing a sort of 'sifflement' with its shell. It was not difficult to detect this phenomenal bivalve, and in a very few minutes he was triumphantly picked out from among his fellows, and put by himself in a spacious tub with a bountiful supply of brine and meal. The news spread throughout the town, and for some days the fortunate Mr. Pearkes found his house besieged by curious crowds. That this Arion of oysters did really whistle is beyond all question. How he managed to do so is not upon record." As may be imagined, the jokes to which this fresh wonder of creation gave rise were unlimited; and Thackeray was in the habit of relating an amusing story of his own experience in connection with it. It appears that he was one day in the shop when an American came in to see this startling freak of nature; after hearing the talented mollusk go through its usual performance, he walked contemptuously out, remarking at the same time that "it was nothing to an oyster he knew of in Massachusetts, which whistled 'Yankee Doodle' right through, and followed its master about the house like a dog." Douglas Jerrold surmised that the oyster had undoubtedly "been crossed in love, and now whistled to keep up appearances, with an idea of showing that it didn't care." The subsequent fate of this interesting creature, says Mr. Walford,† "is a mystery—whether he was eaten alive, or ignominously scalloped, or still more ignominiously handed over to the tender mercies of a cook in the neighborhood, to be served up in a bowl of oyster-sauce as a relish to a hot beefsteak. In fact, like the 'Lucy' of Wordsworth—

> '. . . none can tell
> When the oyster ceased to be.'

But it is somewhat singular that so eccentric a creature should have existed in the middle of London, and in the middle of the nineteenth century, and that no history of his career should be on record." Lastly, although whistling would seem to be as natural an act as that of laughing, yet we are told by Mr. Shortland that it was formerly unknown among the New-Zealanders.* When, too, on one occasion a native of Burmah observed an American missionary whistling, he exclaimed in astonishment, "Why! he makes music with his mouth!" a remark which the missionary noted down in his journal with this note: "It is remarkable that the Burmese are entirely ignorant of whistling." †—*Gentleman's Magazine.*

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* Carl Engel, "Musical Myths and Facts," i, 92, 93.

† "Old and New London," iii, 284.

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SKETCH OF PROFESSOR BENJAMIN SILLIMAN, LL. D.

THE name of Professor Benjamin Silliman is intimately connected with the progress of science in the United States during the former half of this century, and is identified with the beginning of the study of American geology.

BENJAMIN SILLIMAN was born in North Stratford (now Trumbull), Connecticut, on the 8th of August, 1779. His oldest American ancestor on the father's side was believed to have been an emigrant from Holland, but there are reasons for presuming that he belonged to an Italian Protestant family that took refuge in Switzerland, and one of whose members afterward came to America, possibly sojourning for a short time in Holland. His grandfather was a graduate from Yale College, a Judge of the Superior Court of the colony, a member of the Governor's Council, and influential in public affairs. His father served with credit during the Revolutionary War as a brigadier-general, and enjoyed the confidence of Washington. On his mother's side he was descended from John Alden and Priscilla Muggins, of the Mayflower. After attending for a time the public school of his neighborhood, he prepared for college under the tuition of his pastor, the Rev. Andrew Eliot, and entered Yale College in 1792, the youngest but one in his class. He spent the year after his graduation at home, caring for his mother's farm; the next year he took charge of a select school in Wethersfield, Connecticut, and entered the law-office of the Hon. Simeon Baldwin, in New Haven, whence, after completing his three years' course in law, he was admitted to the bar in 1802. While still a law-student—in September, 1799—and when he had just reached the age of twenty, he was appointed a tutor in Yale College.

Up to this time classical instruction had received the predominant share of attention at Yale College, "theological, ethical, and metaphysical subjects were much cultivated, and logic was also a prominent topic"; mathematics was appreciated; much interest had been aroused in astronomy; physics was less cared for, and chemistry had been "scarcely mentioned." Mr. Silliman was considering a proposition to settle down at the practice of the law in Georgia, when in July, 1801, President Dwight informed him that the corporation of the college had several years before resolved to establish a professorship of chemistry and natural history as soon as the funds would admit of it. The time had come when the resolution could be carried into effect, but it was impossible to find in this country a man properly qualified to discharge the duties of the office, while there were reasons that made the appointment of a foreigner inexpedient. The president saw no way but to select a suitable young man at home, and give him time to qualify himself for the professorship; and he had fixed upon Mr. Silliman as the person whom he would propose to the corporation. Mr. Silliman was inclined from the first to consider the offer favorably, because, as he has recorded in his "Reminiscences," "the study of Nature appeared very attractive. In her works there is no falsehood, although there are mysteries to unveil, which is a very interesting achievement. Everything in Nature is straightforward and consistent. There are no polluting influences; all the associations with these pursuits are elevated and virtuous, and point toward the infinite Creator." The professorship was instituted in 1802, with a provision that such time as might be agreed upon should be given the professor-elect to decide whether he would accept the appointment, and Mr. Silliman was chosen professor. Philadelphia then "presented more advantages in science than any other place in the country," and he went there first. Here he enjoyed the instruction, with experiments, of Dr. James Woodhouse, of the Medical College, and had as a fellow-boarder Robert Hare, who had just perfected his oxyhydrogen blow-pipe, and was much occupied with the subject, and enlisted his new friend in his service. He also attended the lectures of Dr. Barton on botany and of Dr. Caspar Wistar on anatomy and surgery, and met Dr. Priestley at the house of the latter. He received valuable suggestions from Dr. Maclean, of Princeton, whom he visited in his transits to and from Philadelphia; and thus he learned to regard the eminent professor as his earliest master in chemistry, and Princeton as his first starting-point in that pursuit, although he had not an opportunity to attend any lectures there. Having attended two winters in Philadelphia, he returned to New Haven and began to write his lectures. His first lecture was delivered April 4, 1804, when he was twenty-four and a half years old, to a class which included, among other men who afterward became distinguished, John C. Calhoun, Bishop Gadsden, and John Pierpont; the subject was the history and progress, nature and objects, of chemistry. Four lectures were given in a week—sixty in the course—and some notices of mineralogy were included.

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* "Traditions of the New-Zealanders," p. 134.

† Howard Malcolm, "Travels in Southeastern Asia," 1839, i, 205.

In the mean time, the corporation of the college had voted to spend ten thousand dollars in Europe during the ensuing year, in the purchase of books and philosophical and chemical apparatus. Professor Silliman applied for the privilege of going as purchasing agent, suggesting that his salary, which would be continued, and the agent's commission would pay his expenses, and he would, at the same time, have an opportunity of improving in his profession. His proposition was accepted; armed with a multitude of letters of introduction, the general effect of which he found to be equivalent to an order—"Sir: Please to give the bearer a dinner, and charge the same to yours," etc.—he spent a year in Europe. He performed experiments with Frederick Accum, the German chemist, and attended the lectures of Dr. George Pearson on chemistry, materia medica, and therapeutics, in London; heard Drs. Hope, Gregory, and Murray, in chemistry and geology; subscribed to Dr. Munroe's and attended Dr. Barclay's courses in anatomy, at Edinburgh; visited the Continent, and made the acquaintance of the most eminent scientific men of the day. Geological science at that time, he says, in his "Reminiscences," "did not exist among us, except in the minds of a very few individuals, and instruction was not attainable in any public institutions." In Edinburgh there were learned and eloquent geologists and lecturers, and ardent and successful explorers, and the contest between the Wernerians and the Huttonians was at its height. Professor Silliman was interested in the discussions, and, giving his attention to the subject, reached a standard of attainment in geology which he believed he could not have gained at home. He read the arguments on both sides, and came to the conclusion on which geologists are generally now tacitly agreed, that "both theories were founded in truth, and that the crust of the earth had been formed and greatly modified by the combined, or sometimes antagonistic and conflicting, powers of fire and water."

Professor Silliman had already attended to the care of the modest collections of minerals belonging to the college. There were a few metallic ores which had been named by Dr. Adam Seybert, of Philadelphia; a small collection which Dr. Semper had brought from England, containing some beautiful specimens, particularly in the lime family; and his own collections made in the mines of Derbyshire and Cornwall, in England, and local specimens obtained in his rambles among the trap-rocks of the Scottish capital, with a purchased suite of Italian polished marbles, all of which "when arranged, labeled, and described in illustration of the mineral portion of the chemical lectures, served to awaken an interest in the subject of mineralogy, and to produce both aspirations and hopes looking toward a collection which should by-and-by deserve the name of a cabinet." One of the first things to be done after returning home was to study the geology of the vicinity of New Haven, in the light of the knowledge that had been gained in Edinburgh. The result of this survey was a report, printed in the first volume of the "Transactions" of the Connecticut Academy of Arts and Sciences, in which an attentive reperusal by the author fifty-two years afterward suggested very few alterations and disclosed no important errors. The cabinet of Mr. Benjamin D. Perkins was shortly afterward purchased for a thousand dollars, and in 1810 the splendid cabinet of Colonel George Gibbs was deposited in the college. The latter cabinet, which attracted visitors from all parts of the country, was bought fifteen years afterward. While Professor Silliman was engaged in arranging it, the Rev. Dr. Ely accosted him: "Why, dominie, is there not danger that with these physical attractions you will overtop the Latin and the Greek?" Professor Silliman replied: "Sir, let the literary gentlemen push and sustain their departments. It is my duty to give full effect to the sciences committed to my care."

An "American Journal of Mineralogy" had been started by Dr. Archibald Bruce, of New York, in 1810, but had been suspended after the publication of four numbers. Professor Silliman, at the suggestion of Colonel Gibbs, and with the approbation of Dr. Bruce, started, in 1818, a journal intended to include the entire circle of the physical sciences and their applications. This was "Silliman's" (now the "American") "Journal of Science," which is still continued under the direction of the son and son-in-law of its founder.

The courses of popular lectures on scientific subjects which were conducted by Professor Silliman in the different cities of the United States, originated in 1808, when a course in chemistry for ladies and gentlemen was proposed to him, and gladly assented to, as a scheme in the interest of scientific progress. A class of about forty-five persons was formed, and listened to the instruction given them apparently with complete satisfaction, for it appeared afterward, the lecturer remarks, in speaking of the matter, that the course "turned on female hinges," and "sentiment lubricated the joints. . . . It was my province to explain the affinities of matter, and I had not advanced far in my pleasing duties before I discovered that moral affinities, also moving without my intervention, were playing an important part." One of the affinities involved the professor, and his marriage to Miss Harriet Trumbull, daughter of the second Governor Trumbull, and one of his hearers, followed in the course of the next year. Many years afterward he was invited to deliver a course in Hartford—the first out of New Haven; then followed courses in Lowell, Boston (where "the Orthodox and Unitarian influence was united in his favor," and where he returned to lecture in several successive years afterward), other New England towns, and New York. In 1843 he lectured in Pittsburg, where he received most "vivid demonstrations of kind and gratified feelings"; the next year in Baltimore, where he found that "people who came for once, staid"; and afterward in Baltimore again, Mobile, New Orleans, Natchez, at Washington before the Smithsonian Institution, and in St. Louis. The calls to lecture continued actively through twenty-three years, from 1834 to 1857. In summing up the results of these courses, Professor Silliman expressed a feeling of satisfactory assurance that he had popularized science; that at no period of his life had his efforts been more useful, both to his country and his family; and that there was no part of his professional career which he reflected upon with more satisfaction.

He was accustomed to explain the success of his lectures, and the uninterrupted interest they attracted, by stating that he always prepared them "with all possible care, and arranged every experiment and illustration so as to insure success. Then I could stand before the largest audience without anxiety or embarrassment; could, without manuscript, clearly state and explain my subject, and, when the proof became necessary, I could perform the experiments successfully and even beautifully, and exhibit the specimens which some other truth demanded, to insure conviction."

In 1830 Professor Silliman made a visit of exploration to the valley of Wyoming and its coal formations, where he examined some hundred mines and localities of coal, extending through forty miles in length; in 1832–'33 he was engaged, under a commission from the General Government, in a scientific examination on the subject of the culture and manufacture of sugar; and in 1836 he made a tour of investigation among the gold-mines of Virginia.

In 1840 an association of geologists was formed in Philadelphia for the purpose of promoting the progress of their science and its applications in this country, and Professor Silliman was chosen its first president. This society was in time succeeded by the "American Association of Geologists and Naturalists," and the latter eventually became the "American Association for the Advancement of Science."

In 1849 Professor Silliman, having reached the age of seventy years, tendered a resignation of his professorship, to take effect at the end of the ensuing academic year. The corporation, only half accepting his resignation, requested him to continue his lectures in the department of mineralogy and geology, should his life and health be spared. Later, at the request of the corporation, he reconsidered his resignation, and continued in the full occupation of his professorship till 1853, when, "wishing to go out before he should be compelled by infirmity, and to march out of the camp with colors flying," he retired finally. "Thus," he remarks in his journal, after referring to the public notices that were taken of his retirement during commencement-week, "I have finished my regular connection with Yale College, after having been almost fifty-four years an officer of the institution—three years a tutor, fifty-one a professor, and almost fifty a lecturer. . . . I seem to have attended my own academic funeral, and many to be the mourners on the occasion." The corporation requested him to continue as a professor emeritus, with the right to vote in the academical and medical faculties. His professorship was divided, and he had the satisfaction of seeing his son placed in the chair of Chemistry, and his son-in-law, Professor Dana, in that of Geology and Mineralogy. The name of Silliman was given to both chairs.

Professor Silliman was still to continue a prominent figure before the public, kept so by other events than those connected with science and the affairs of the college. A few months after his resignation the Kansas-Nebraska controversy rose to its height, and the Republican party was born amid the convulsions it excited. Professor Silliman had always abhorred slavery, and he saw in these disputes great moral issues, and the question of the equal rights of citizens of all the States to settle in the Territories and defend themselves there. His active interest in these matters, and the works by which he showed it, called out bitter partisan reprobation, and this in turn invoked eloquent and deserved eulogies of his pure character and his attainments in science from Senators Foster and Dixon in the United States Senate.

Professor Silliman kept even pace with the progress of science and scientific ideas as they were developed through all his career, and let his religious faith shine at the same time with a light of even brilliancy. The possibility that there was a conflict or could be a conflict does not seem even to have occurred to him. From his earliest college-days, piety and a firm devotion in religious faith seem to have formed a prominent side of his character; yet he never hesitated to accept the most startling discovery, when it proved deserving acceptance. "Now, at eighty-two and a half years of age," he says, March 1, 1862, "I can truly declare that, in the study and exhibition of science to my pupils and my fellow-men, I have never forgotten to give all the honor and glory to the infinite Creator, happy if I might be the honored interpreter of a portion of his works, and of the beautiful structure and beneficent laws discovered therein by the labors of many illustrious predecessors. For this I claim no merit. It is the result to which right reason and sound philosophy, as well as religion, would naturally lead. While I have never concealed my convictions on these subjects, nor hesitated to declare them on all proper occasions, I have also declared my belief that while natural religion stands as the basis of revelation, consisting as it does of the facts and laws which form the domain of science, science has never revealed a system of mercy commensurate with the moral wants of man. In Nature, in God's creation, we discover only laws—laws of undeviating strictness, and sure penalties annexed for their violation. There is associated with natural laws no system of mercy; that dispensation is not revealed in Nature, and is contained in the Scriptures alone. With the double view just presented, I feel that Science and Religion may walk hand in hand." "For his own part," says Professor Fisher, from whose rich biography we have drawn freely in the composition of this sketch, "he felt that the Bible was a revelation from God. . . . Not being in the habit of resorting to the Scriptures for information in physical science, he had valued its early pages for the pure and sublime theism which they inculcated. . . . Nor did he deem it necessary to suppose that the author of Genesis, however instructed by a higher light, was himself cognizant of the truths of geology, especially the truth of the great antiquity of the globe, and the length of time consumed in the geological changes." The idea of the length of geological time, as presented in his lectures, was novel to the majority of his auditors, and evidently shocked the prejudices of many of them, but he maintained it with vigor, and generally left a good impression regarding it in the end. Concerning the opponents of these ideas among the clergy, he wrote to Dr. Hitchcock in 1837: "I believe, with you, if they were masters of our subject, they would think as we do. Some of them are candid and forbearing; others find no insuperable difficulties; others are silent because they feel that they do not understand the matter; but a few are loud, confident, and uncharitable, while it is obvious they know not whereof they affirm, . . . but I see a strong purpose on the part of some to hold no terms with geology, and to insist upon the literal and limited understanding of the history; but they will find themselves deserted, for the matter will in time come right." Of a particular attack on the geological theory he wrote to Professor Hitchcock: "You and I *know* that any attempt to impair geological evidence, or to reconcile it with the popular view of time, must be abortive. No matter how violent or bitter our assailant may be, doubtless he will be more so in proportion to his ignorance of geology and to the strength of his prejudices."

Mrs. Silliman died in January, 1850, and Professor Silliman was married a second time, in the following year, to Mrs. Sarah I. Webb, of Woodstock, Connecticut. His death was apparently induced by a neuralgic attack which he incurred from attending a meeting on behalf of the Sanitary Commission, on the 13th of November, 1864. He was confined to the house for several days, but seemed afterward to recover, and made several calls in the neighborhood; but on the 24th—Thanksgiving-day—he died, instantly and without a struggle, just as he had remarked that he might perhaps go out to church. The disease from which he died was supposed to be an affection of the heart.

Professor Silliman, says his biographer, Professor Fisher, would have been the last to claim that he had that rare insight of genius which divines the secrets of Nature. His whole turn was more practical than speculative. "His perceptions were quick, his judgment sound, and all his mental operations were marked by good sense." His qualities "well fitted him for his peculiar work, and that was to collect and diffuse scientific truth. . . . Nor is he without merit as an investigator, although his distinction does not lie here. He was never very careful to claim for himself the credit of scientific discovery. At the same time, he took delight in bringing honor to the discoveries of others." He prepared an edition of Henry's "Chemistry," which appeared in 1808, with the modest announcement, "To which are added notes by a professor in this country." While this work was going through the press, a remarkable meteor passed over New England (December, 1807), and exploded over Weston, Connecticut, where several stones fell to the ground. He visited the scene, and, besides publishing a popular account of the facts in the "Connecticut Herald," made them the subject of a scientific examination and report before the Philosophical Society of Philadelphia, which was afterward republished in the "Memoirs" of the Connecticut Academy of Arts and Sciences, and read aloud in the Philosophical Society of London, and in the Academy of Sciences in Paris. His two visits to Europe (the second one was in 1851) were followed by books of travels, both of which were received with great satisfaction, while the earlier one (1810) was highly commended, abroad as well as at home, as one of the best works of its class. He was the first to obtain potassium in this country, and the first to notice and record the effect of a powerful battery in volatilizing carbon and transferring it from the positive to the negative pole in a state of vapor. An account of his experiments with the oxyhydrogen blow-pipe was published in the "Memoirs" of the Connecticut Academy of Arts and Sciences in 1813. He published an account of a journey between Hartford and Quebec in 1820, an edition of Bakewell's "Geology" in 1829, and a text-book on chemistry, in two volumes, in 1830. It was largely through his influence that the Scientific School, started by the younger Professor Silliman in 1842, which was afterward endowed by the gentleman whose name it bears as the Sheffield Scientific School, was adopted by the college as one of its departments, in 1846 and 1847. Professor Silliman was for many years in regular correspondence with the most eminent scientific men of Europe, among whom may be named Berzelius, Robert Bakewell, Humboldt, Carl Ritter, Lyell, Sir R. I. Murchison, Richard Owen, Daubeny, Herschel, and Dr. Mantell. Some of these he never knew personally, but was brought into communication with them through a common interest in science.

CORRESPONDENCE.

WRITTEN AND UNWRITTEN CONSTITUTIONS.

Messrs. Editors:

A PERUSAL of your article in the March number of "The Popular Science Monthly," entitled "Law against Right," left an unpleasant impression on my mind, occasioned by the depreciatory criticisms upon lawyers with which it abounds. I am the more surprised at this, as, during many years' attentive reading of the "Science Monthly" I have had occasion to note the fairness and general freedom from invective which pervade your method of dealing with all questions discussed. It is not my purpose to express any opinion upon the merits or demerits of the law of copyright as it exists either in this country or in England, the subject which seems to have inspired your article. I only desire to say a word in behalf of lawyers as a professional class, and to express the opinion (and I say it after an active practice of nearly forty years in several different States, and some travel and observation abroad) that the lawyers in this country, under written constitutions, are no more given to "quibbles, devices, and sharp interpretations of law," than those of other countries.

While lawyers are responsible for the manner of presenting their clients' cases in court, judges for a proper interpretation of the laws, and jurors for such an application of the law to the facts of the case as will result in a rightful verdict, neither are directly responsible for the condition of the law itself, but must take it and apply it as they find it. Right here comes in the difficulty as to written as compared with unwritten constitutions of which you complain. It is no doubt true that in this country judges are bound by the fundamental written law, but they are not bound to sacrifice its main underlying purpose upon a given subject to the mere letter. The principle is as firmly rooted in our jurisprudence as in that of any country, that the mere technical letter of the text must give way to the clear purpose of the ordinance or law as gathered from a reasonable interpretation of the whole of the law bearing upon the particular subject; but where the meaning is clearly apparent it must prevail: if it is right, there is no ground for complaint; if wrong, the people here constitute the only tribunal to correct the error, and they alone should be held responsible for any resulting injustice, and not the lawyers or judges who are bound by their oaths to apply the law as they find it. The great body of the law is, of course, both here and in England, statutory; as to this the distinction as to written and unwritten law does not exist, and I hazard the opinion that as to this the administration of justice in England is not more elastic or less technical than here.

The main drift of your article tends to the point that unwritten constitutions provide a more ready means of attaining the ends of justice than written constitutions. The latter may afford some temporary advantages, but upon the whole I think the view you present is erroneous.

The science of law has had its conflicts with ignorance, prejudice, and false ethics, like most other departments of human thought, and I think it has made some progress, and quite as much progress in America as in Europe. The substitution of written for unwritten constitutions may be attended with some temporary evils and delays of justice, but upon the whole it can not be denied that they furnish more effectual barriers against the encroachments of arbitrary power upon the liberties of the people than mere traditional precedents which may be swept away under the spur of popular clamor, or set aside under the pressure of a ministerial or administrative crisis. The fundamental law should be in such condition that it will resist the pressure when the greatest strain comes upon it, for it is then that it is especially wanted. When the ship of state is sailing under clear skies and over smooth seas it matters little whether there is any constitution, written or unwritten; but when the stress does come, and either people or ruler *wants* to break down the barriers which the lessons of history and human experience have set up in the form of a constitution, it is then of supreme importance that the restraining power of the fundamental law should be an iron hand and not an elastic gutta-percha string, to be stretched at pleasure. Now, which is most likely to effect this purpose, the written letter, from the meaning of which there is no escape, or those traditional precedents which go under the name of unwritten constitutions, and which the ingenuity of man can readily torture into a construction favorable to the purpose of temporary usurpation?

The tendency of the times is to favor not only written constitutions but the codification of law, remedial and otherwise. The great body of the common law, as we all know, is not the work of Legislatures but the creation of judges, which has long obtained in this country, and upon the superstructure of which judges have gone on building, creating a vast fabric of case-law, so voluminous and unwieldy that no mortal man, no matter how great his ability or attainments, can within the limits of human life fully master it. To remedy this, the evolution of the science of law has developed a method of collecting together, from the vast libraries of reported cases and judge-made laws, the settled principles therein contained, and of reducing them to a carefully arranged and harmonious system known as codes. This codification, when enacted by the Legislature, becomes the written law of the land, and takes the place of the uncertain elastic line of precedents founded on cases, and which, resting in the "bosom of judges," might be colored by their prejudices or warped by their interests or passions. If these views are correct, instead of unwritten law, either fundamental or statutory, furnishing the best means of promoting the ends of justice, the reverse is true, and the science of jurisprudence must advance along the paths of written laws, inflexible in their terms, and from which there is no escape other than through prescribed and appropriate methods of amendment. **Charles R. Street.**

Huntington, Suffolk County, N. Y.,
March 26, 1883.

RECLAMATION.

Messrs. Editors:

In the April number of "The Popular Science Monthly," page 795, Mr. H. H. Bates cites Maxwell's article, in the "Philosophical Magazine" for 1877, page 453. More than five years before the publication of Maxwell's note, I had shown ("Proc. Am. Phil. Soc.," xii, 394) that the ratio of the vivial of wave-propagation to the vivial of its oscillating particles is 5 : 9, and that the ratio is determined by the secondary center of oscillation between the ethereal center of gravity and the ethereal center of linear oscillation. Maxwell gave no reason for his deduction, and his executors have been unable to find any among his papers.

Pliny Earle Chase.

Haverford College, Pa., *April* 7, 1883.

EDITOR'S TABLE.

SCIENCE, LITERATURE, AND THEOLOGY.

The discussion of the relations of these great elements of thought proceeds vigorously. "Line upon line and precept upon precept" accumulate; while the last instructive line respecting science and literature comes from the London "Times," and the last weighty precept concerning science and theology from the President of Harvard University.

In connection with the meeting of the civil engineers, held recently in London, the "Times" of that city makes the following significant declarations, which it is desirable to place upon permanent record, both as the deliberate utterance of an influential organ of public opinion and because of the incontestable truth of the statement itself. The "Times" says:

"Meetings such as that of Saturday evening remind us not merely of the services of a particular branch of science to mankind, but of the remarkable determination of human activity to scientific pursuits which is characteristic of the present age. Literature no longer holds the place it once did in the minds of men; nor does it command, as it once did, the services of the most powerful intelligences. The protest against an education wholly or chiefly consisting of the study of the classics is the result of a profound change in the conditions of life. Men have not deliberately and as a result of abstract reasoning discarded one set of studies in favor of another. On the contrary, they have discovered, often to their great chagrin, that a complete intellectual displacement has taken place. That which was taken up under protest, as a thing too closely connected with utilitarian pursuits to be quite worthy of a man of intellect, has now pressed into its service the chief intellectual power of the country. The tide of intellectual effort sets strongly in the direction of science, just as at an earlier period it set in the direction of letters. The teachers and leaders of the day, the real dominant forces of the age, are the men of science, the investigators of natural phenomena, not the thinkers, philosophers, or metaphysicians who formerly gave their name to sects, and made all the world their partisans. Nothing is more remarkable than the profound respect of the scientific conception associated with the name of Darwin, not on science only, but on literature, art, morals, and, in short, upon life. Some will tell us that all this is a lamentable result of the materialism of the age; but we naturally ask how it happens that some centuries of a non-scientific or literary culture left us a prey to the materialism it is supposed to antidote? It is untrue, moreover, that material interest has been the great impelling force. The great discoveries of science have usually been made by men seeking no material reward, and, as a matter of fact, receiving very little. Science pursues her own way for the most part, and her discoveries are afterward utilized by men eagerly seeking for the means of material enrichment. Even when it is a question of so practical a thing as a new dye, it will be found that the chemist, searching into the properties and combinations of matter, comes upon the secret unawares, while the manufacturer and the dyer reap the profits. It is, indeed, only upon these terms that Nature yields up her secrets."

Quite in the spirit of the foregoing, though in a different and more special direction, is the article of President Eliot, of Harvard, in the "Princeton Review" for May, "On the Education of Ministers." President Eliot declares that the education of the clerical profession has fallen so far behind the age as to be out of relation with it, and to have consequently lost its ancient commanding influence, and even resulted in the degeneration of the clerical character. In the early part of his able article he shows the eminent position formerly occupied by the clergy as intellectual leaders. They were founders of colleges, and the largest professional class among the students. While a hundred years ago in Harvard, Yale, and Princeton the clerical graduates were respectively 29, 32, and 45 per cent, they have now fallen so far behind that "in the six years from 1871 to 1876 the percentage of ministers among the graduates of the same institutions was, in Harvard, 5¾; in Yale, 7; in Princeton, 17." President Eliot then glances at the great changes that have gone forward in society during the last hundred years, profoundly affecting the beliefs of men on many important questions, and bringing new and extensive knowledge to bear upon practical and everyday problems in relation to social affairs. Coincident with these movements, the temper of the public mind has undergone a wonderful change within a century upon several points which vitally affect the clerical profession. In the first place, the weight of all authority has greatly diminished, and the sources of recognized authority are quite different from what they were a century ago. The priest, like the secular ruler, has lost all that magical or necromantic quality which formerly inspired the multitude with awe; and the divine right of the minister is as dead among Protestants in our country as the divine right of kings. . . . Again, the people in these days question all things and all men, and accept nothing without examination. They have observed that discussion often elicits truth, that controversy is useful on many difficult subjects, and that in some circumstances many heads are better than one; hence they have learned to distrust all *ex cathedra* teaching, and to wait for the consent of many minds before giving their adhesion to new doctrines. We hardly realize how very recently the masses have acquired these invaluable habits, or how profoundly these habits have affected the position of the minister."

But it is in the recent progress of science that President Eliot finds the influence by which the position of the clerical profession is most profoundly affected in these times. On this subject he says: "We come now, in the fourth place under this head, to the most potent cause of change in the relative position of the ministry within this century, namely, the rise and development of physical and natural science. The immense acquisitions of actual knowledge which have been amassed in this new field, the great increase of man's power over nature, the consequent changes in each man's relations to his fellow-men and to the physical earth, including the wonderful expansion of his interests and sympathies, his emancipation from superstitions, and the exaltation of his prospects and hopes, are all facts of the utmost moment to the race; but it is not these facts, tremendous though they are, which most concern us in the present discussion. The important point for us now to observe is that, during the growth of natural science, a new method or spirit of inquiry has been gradually developed, which is characterized by an absolute freedom on the part of the inquirer from the influence of prepossessions or desires as to results. This spirit seeks only the fact, without the slightest regard to consequences; any twisting or obscuring of the fact to accommodate it to a preconceived theory, hope, or wish, any tampering with the actual result of investigation, is the unpardonable sin. It is a spirit at once humble and dauntless, patient of details, drawing indeed no distinction between great and small, but only between true and false; passionless, but energetic, venturing into pathless wastes to bring back a fact, caring only for truth, candid as a still lake, expectant, unfettered, and tireless.

"The achievements of scientific inquirers, animated by this spirit of sincerity and truth, have been so extraordinary within the past sixty years, and this candid spirit is in itself so admirable, that the educated world has accepted it as the only true inspiration of research in all departments of learning. No other method of inquiry now commands respect. Even the ignorant have learned to despise the process of searching for proofs of a foregone conclusion. Apologetics have ceased to convince anybody, if they ever did. Thus the civilized world has set up a new standard of intellectual sincerity, and Protestant theologians and ministers must rise to that standard if they would continue to command the respect of mankind. How different was the situation of the profession when diplomacy was the only other learned calling! Even the legal profession, as it was gradually differentiated from the clerical, made no such sharp requisition of mental honesty and independence. It is the electric light of science which has made white and transparent the whole temple of learning. These remarks imply that ministers, as a class, and as a necessary consequence of the ordinary manner of their education and induction into office, are peculiarly liable to be deficient in intellectual candor; and that is what I, in common with millions of thoughtful men, really think; and I think further that this belief on the part of multitudes of educated men, most of whom are silent on the subject, is a potent cause of the decline of the ministry during the past forty years. The fault is quite as much that of the churches or sects as of the individual ministers; for almost every church or sect endeavors to tie its members, and particularly its ministers, to a creed, a set of articles or a body of formulas. These bonds are put on by most ministers at an early age, and must be worn all their lives, on peril of severing beloved associations, or, perhaps, losing a livelihood. The study, reading, and experience of fifty years are supposed to work no essential change in the opinions of the youth. The creed or the articles may be somewhat vague and elastic, but can not honestly be stretched much. Now, the lay world believes in the progress of knowledge, because it has witnessed progress; and it is persuaded that there must be incessant progress in theological science as well as in all other branches of learning. It does not see metaphysicians, physicians, historians, chemists, zoölogists, or geologists, committing themselves in youth to a set of opinions which is to last them a lifetime, or even a day; on the contrary, they see all these classes of scholars avowedly holding their present opinions subject to change upon the discovery of new facts, or of better light upon old facts, and, as a rule, actually modifying their opinions in important respects between youth and age. Indeed, fixity of opinion is hardly respectable among scholars. If it be said that there can be no progress in theology, because revelation was a fixed historical quantity, the answer is, that revelation, like creation, must be fluent; or, in other words, that the interpretation of revelation to the mind of man must be like the interpretation of creation, ever flowing, shifting, and, if the mind of man improves, improving. No other profession is under such terrible stress of temptation to intellectual dishonesty as the clerical profession is, and at the same time the public standard of intellectual candor has been set higher than ever before. This is the state of things which deters many young men of ability and independence from entering the profession, and causes the acknowledged dearth of able ministers."

HEBER NEWTON AND THE HERESY-HUNTERS.

THESE observations of President Eliot find an apt illustration in the case of the Rev. Heber Newton, which is now attracting a good deal of public attention. Intelligence and liberality have undoubtedly made great headway, and put the theological profession out of joint with the enlightenment of the times; but there is a pious-ignorant class of great influence that is not to be overlooked. Is it indeed so certain whether intelligence or stupidity is in the saddle in the popular theological arena? Certain foolish fanatics have combined to hunt the Rev. Heber Newton out of the Episcopal Church, on the old charge of heresy. And what is the pretext of this action? Why, the reverend gentleman appears to have been doing a little thinking on his own account—the mortal sin of theology! They say he made a solemn bargain, a vow, that he would do no independent thinking, have no opinions of his own, but simply re-echo the authorized creed, and that, having now begun to inquire, he is no longer fit to remain in the Christian Church.

Mr. Newton has ventured to think and to speak about the use and abuse of the Christian Scriptures—a proper subject, one would suppose, for a clerical teacher. He has opinions, sincere opinions, which he deems important, about the inspiration of the Bible, and how that phrase is to be understood. Now, it is incontestable that there has grown up an interesting and important accumulation of knowledge about the Bible in recent years, and knowledge determines opinion, in spite of all the theology in the world. And so it comes about that Mr. Newton, having convictions upon the inspiration of the Bible, must suppress them, and thus go along in comfortable hypocrisy, or express them, and be turned out of the Church. This was the dark age policy, with certain grim accompaniments; but is the stupid bigotry of by-gone ages still in the Episcopal saddle? We shall see.

Meantime, we venture to suggest that the heresy-hunters widen a little the scope of their operations; for, if they are going to make thorough work in purging the Church from all advanced opinion, and turn out everybody who blinks at the literalness of the verbal creed, they will have plenty of business, and can find a good many more cases quite as bad as that of Mr. Newton. We are told that the case is simply one of breach of contract. Enterprising editors, to whom an ecclesiastical trial would be as much of a godsend as the Saratoga horse-races, are especially solicitous about Heber Newton's contract to preach certain things which he is bound and sworn to preach while he remains in the Church.

Now, suppose these heresy-hunters institute an inquiry as to the extent of clerical dereliction in maintaining acknowledged Christian foundations. There can not be the slightest doubt as to the fundamental importance of a belief in hell, in our system of orthodox theology. It is the basal, and topmost, and all-impelling idea. The conception of hell is the corner-stone of the orthodox edifice, the key-stone of the orthodox arch; and, what the fires under the boiler are to the steam-engine, that are the fires of hell to the orthodox "scheme of salvation." The idea pervades the Christian theology and hymnology, and has been preached, sung, and prayed now for some eighteen hundred years, the proclaimed object of the whole theological system being to save men from hell! Such being the theological import and historic prominence of the doctrine, which is explicitly conserved in the creeds, and solemnly avowed by all orthodox clergymen, would it not be well to look a little into the growth of modern heresy regarding it in the very bosom of the Church? How is it about the enforcement of the hell-fire contracts? It would be interesting to know how many times the fundamental hell-doctrine is referred to in the course of ordinary pulpit ministration, and how it is slurred over and put aside and ignored as if the preachers were ashamed to allude to it. We think an inquest of this sort would reveal the fact that there is a good deal more reservation, and private interpretation, and playing fast and loose with creed and Scripture, than our heresy-hunters are aware of; and, if they pushed their inquisitorial work very far in this direction, they would be pretty sure to vacate half the pulpits in the land.

THE BANQUET TO DR. HOLMES.

All who had the good fortune to be present at the complimentary dinner to Dr. Oliver Wendell Holmes, given by the Medical Faculty of New York at Delmonico's, April 12th, will long remember it as a rare occasion. It was a most appropriate tribute of honor to the distinguished guest, and the taste and elegance displayed in the banquet and the excellence of the judiciously chosen speakers did abundant credit to the managers of the affair. But their task was not difficult, for hardly ever before were such favorable elements combined to give success to such an occasion. In the first place, if the committee had gone around the world with lanterns, over all the lines of latitude and longitude, they could not have found another so eligible a man to exploit in the festive and honorary way as Dr. Holmes. Known, admired, and loved wherever the English language is spoken, illustrious as a poet, humorist, novelist, essayist, conversationalist, and lecturer, and, finally, so specially distinguished as an anatomist and physician as to command the high regard of the medical profession in the metropolis of the country, nothing was wanting to give inevitable success to any complimentary expression of unaffected admiration and profound respect. Delmonico is, of course, a constant quantity, and can be counted on for the perfection of a feast, but the intellectual furnishings in this case were spontaneous, varied, and also of the highest quality. When prose was exhausted, poetry came to the rescue, eloquence flowed as freely as the wine, divinity refused to be outdone by medicine in praise of the guest, the press claimed him as a typical journalist always ready for sagacious comment upon memorable events, and literature and science pressed their rival claims for the inscription of the name of Holmes upon their banners. The doctor took it all with the most gracious good-nature, knowing as well as anybody that there was a great deal more truth than flattery in the cordial utterances of which he was the target, and he gave the supremest proof of imperturbable good-humor by submitting to the insatiate exactions of a crowd of autograph-hunters who cornered him for their diabolical purposes after twelve o'clock.

LITERARY NOTICES.

Dynamic Sociology, or Applied Social Science, as based upon Statical Sociology and the less Complex Sciences. By Lester F. Ward, A. M. In two volumes. New York: D. Appleton & Co. Pp. 726 and 698. Price, $5.

In the rush of publications from a teeming press there now and then comes a work of such grave and exceptional import as to demand a special and careful consideration, and among these are to be included the two comprehensive volumes now before us. Under the technical and somewhat unattractive title of "Dynamical Sociology," Mr. Ward has made an original and able contribution to the large and very important subject of social science. Although he is, of course, indebted to many sources for his materials, yet the handling of the topics is his own. His work is not a compilation or *résumé* of previous promulgations, but an elaboration of his own independent views; and he has constructed a system which, from its breadth, its scientific basis, and its elaborate method lays claim to the character of a philosophy.

It must be confessed that the presumptions in these times are strongly against the novel and ambitious reconstructions of thought, which so frequently challenge public attention, and, if the author were asked in this case for his credentials, he would probably say that they must be found in the book. Yet Mr. Ward is well known by his scientific, economical, and social contributions to the magazines, as well as by other publications of recognized merit, and if he has not before issued any considerable book, it is probably because he has been absorbed for the last ten years in the preparation of the extensive treatise now published.

Mr. Ward's title, as we have intimated, is unfortunate. Sociology is a forbidding word—snarled at by petty purists as illegitimate—and not yet settled and defined in familiar speech; while the kind of sociology designated as "dynamical" only deepens the obscurity, and makes it necessary, at the outset of any intelligible notice of the work, to explain what is meant to be indicated by these terms. This will, moreover, furnish the key to the method of the book.

The author assumes sociology to be a science already so well established as to take proper rank in the family of sciences. It deals with the laws of social phenomena, as botany deals with the vegetable kingdom, and zoölogy with the animal world. But science is of two kinds, pure and applied, the former consisting of an exposition of facts and principles, and the latter of their practical applications for purposes of utility. Pure sociology, therefore, confines itself to the classification of the facts and the elucidation of the principles of social phenomena. It deals with society by the natural history method, describing, analyzing, comparing, and generalizing the comprehensive data of the subject. Its aim is simply the establishment of a body of truth, without the formal consideration of its uses. This is sociology as generally and properly understood.

But Mr. Ward thinks that, when the practical applications of this science are to be considered, new terms are needed to mark an important distinction, and so he uses the word *statical* to characterize its common scientific form. But this established sociology, or "Statical Sociology," which consists of the classified facts and generalized principles of the science, he holds to be of a negative or passive kind, and he says that this has hitherto proved sterile or unproductive of benefit to the community. Like the other sciences, it needs application to make it useful and valuable. But this application involves active human agency, the control of social effects, and, as man's effort and directive power is here the main idea, he expresses this element of force by the term *dynamic*, and calls this branch of the subject "Dynamic Sociology." On this view, statical sociology deals with the great processes of nature, with genesis and natural evolution; while dynamic sociology treats of psychic human agency, and artificial results in the social sphere.

Mr. Ward maintains that the time has come when sociology must pass formally from the theoretic to the applied stage. While admitting the impracticability of most of the measures that have aimed at social amelioration, he nevertheless considers that we can no longer avoid the endeavor to derive certain fundamental principles of social action that shall bring the phenomena of society under the same intelligent control that science has long made possible in the division of physical phenomena, and guide the active interference of man in the direction of social affairs and to the accomplishment of social ends. This he assumes to be the art stage in the development of the subject in which purposed artificial agencies supplement and carry forward the natural processes of development for the attainment of the highest fruits of human progress.

Mr. Ward devotes his first volume mainly to "Statical Sociology." It opens with a long introductory chapter, presenting a general view of the entire scheme. This is followed by two historical chapters, reviewing the two great modern systems of Auguste Comte and Herbert Spencer, in a manner sufficiently full for his general purpose. Then follow four chapters dealing with the most fundamental principles of cosmical development, or evolution in the domain of purely natural phenomena. These are entitled respectively "Cosmogeny," "Biogeny," "Psychogeny," and "Anthropogeny," dealing with the genesis of worlds, of life, of mind, and of man, and naturally leading up to the higher department of "Sociogeny," or the genesis and development of human society. Following the current terminology, we have here to do with pure sociology only, or its treatment from the point of view of the laws of nature. As a comprehensive exposition of the doctrine of evolution, this volume has great merit.

Sociological study thus far, Mr. Ward maintains, has chiefly given attention to the genetic or unconscious progress of society. The causes that have produced this passive or unconscious social progress are subjected to a searching analysis, and are found in the *social forces*. These consist fundamentally in desires, but they are desires which inhere permanently in the nature of man as a living organism. They are divided into two great groups, the original, or essential, and the derivative, or non-essential, social forces. The essential forces are those desires which belong to man as an animal, and are necessary to the maintenance of the primary functions of nutrition and reproduction. The non-essential forces are those desires which have been developed in the course of evolution, and they are divided into the æsthetic, the emotional, or moral, and the intellectual social forces. The primary forces, which have led to social transformations, are, therefore, blind forces, which result to the performance of acts with no reference to their ultimate effects.

Mr. Ward's argument for dynamical sociology, to which his second volume is devoted, is not easily presented in a paragraph, but it is substantially as follows: The ultimate end of human action is well-being or *happiness*, but this can not be attained through direct effort; it requires means. There are five proximate ends standing in as many degrees of remoteness from the ultimate end, the attainment of any of which is equivalent to the attainment of all the less remote ones, and the ease in securing which is directly proportional to their remoteness. These proximate ends, therefore, constitute so many means to the attainment of the ultimate end of well-being.

The first of these proximate ends is human progress itself, which, in order to be true progress, must secure the ultimate end. But progress is not in any proper sense attainable by direct effort; it must itself be sought through means. The means of progress, which therefore become the second proximate end, must consist in the proper kind of *action*, but such action is only less difficult of direct attainment than is progress itself. Here, again, the necessary means must be adopted to secure the end.

The higher forms of action, such as seriously affect the condition of society, are chiefly the result of the ideas or opinions entertained. In a general sense, then, *opinion* may be regarded as the means to action, and hence as the third proximate end. But direct attempts to influence opinion are also practically futile; means must be employed here, as before.

Ideas and opinions rest upon the data in possession of the mind. Such data, to conduce to the several proximate ends, and through these to the ultimate end of well-being, or happiness, must be in harmony with reality. In other words, the data of opinion must consist in *knowledge*. Knowledge, therefore, is the fourth proximate end, the attainment of which will carry with it that of all the less remote ones, and also that of the ultimate end. Now, knowledge may be attained by the direct effort of the individual; but the mind is most receptive of it during the plastic period of youth, before an appreciation of its value can have been acquired sufficient to insure the effort to obtain it. To leave it to enforce itself, therefore, is virtually to fail of its attainment, so that this also is to be secured only through means.

The means to knowledge is instruction or *education*. This is defined as "the universal distribution of the most important extant knowledge." As an end, education can be easily secured by direct effort, even of society in its collective capacity. It differs from all the other ends in requiring no further means for its accomplishment than the mere mechanical appliances. Education, therefore, constitutes the most remote proximate end, and the *initial means* to the attainment of all the less remote ends, and also of the ultimate end of the general welfare. All these ends may, therefore, be wholly neglected and left to take care of themselves, and the entire energy of society may be concentrated upon this most remote end, or initial means, to the highest social progress.

The second volume of Mr. Ward's work opens with a chapter treating chiefly of man's relation to the universe, which he insists must be more clearly conceived before any further progress can be made in philosophy, and it ends with a statement of the definitions and theorems of dynamic sociology. The remaining six chapters are devoted to the detailed consideration of the six theorems, one being given to each of the great ends, in the order in which we have noticed them. The work, therefore, closes with a radical discussion of the claims of education as above defined, as the supreme essential condition to further and higher social progress.

No idea can be given in such a brief notice as this of the number of important subjects of great public interest at the present time that are traversed by Mr. Ward in these solid volumes. The work is more constructive than critical, but it deals throughout with live topics and urgent public problems. The author takes radical issue with his philosophic predecessors, and arrives at new results for which he claims the sanction of science and reason. As the reader will perhaps have inferred, the drift of his reasoning is toward a great extension of coercive agency and government control in the work of social progress. His work is, in fact, a vigorous and systematic assault upon the doctrine of *laissez faire*, and the policy of leaving things to spontaneous influences and the self-regulation of private enterprise. It is, perhaps, the strongest defense yet made of the enlargement of state functions for the direction of social affairs. The task was an ambitious one, but the manner of its execution proves that it was not presumptuous.

The merits of Mr. Ward's work are unquestionably such as to entitle it to the serious attention of students; but, aside from its intrinsic claims, its logic is so strongly in the direction of predominant American tendencies, that it is sure to be welcomed by many as a representative exposition of American policy and thought. It appeals strongly to different classes of thinkers. Boldly coping with the ripened systems of the Old World, it will commend itself to many who are ambitious about the development of philosophy on this side of the Atlantic. The work is, moreover, of an eminently practical sort, and deals with the relations of political and social science in their bearing upon the interests of the community in such a way as to entitle it to the consideration of statesmen and political economists. Besides, as it offers a new synthesis of facts, and aims to co-ordinate into a uniform scheme the accepted truths of all the sciences, it can not fail to awaken the interest of thinking scientific men in all departments. And, as the philosophy of religion is broadly and independently treated, the work is certain to have an interest for all schools of religio-philosophic speculation and inquiry. As Mr. Ward's work is thoroughly up to the times both in substance and spirit, the reader will of course be prepared for a good deal of freedom and boldness in discussion; but the author is no trifler, though, in the courageous expression of his convictions, he goes no further than is justified by the practice of this questioning age.

. We may add that the work is written in a style that will commend it to popular readers. Mr. Ward makes himself perfectly understood, and without effort on the part of those who follow him. He is at times diffuse, and we think the work would have borne considerable condensation, but, believing that the views he desires to promulgate are important, the author seems to have been only solicitous for that fullness of statement that shall give completeness to his meaning in the reader's mind. The references to collateral discussion are numerous throughout the text, so as to facilitate the following out of any special argument, and the index to the work is careful and exhaustive. Mr. Ward has been arduously occupied upon his treatise for a long time, and may be congratulated upon the perfection of its form as a product of the book-making art.

It has been our purpose in this notice simply to give the best account we could in so brief a space of the general characteristics of the "Dynamic Sociology." Our readers hardly need to be reminded of our decisive dissent from the doctrines of the school of which Mr. Ward will now easily take the place of the ablest leader, but we have refrained from criticism, that our statement might be as far as possible fair and unbiased. There is, at any rate, a great deal in this work that is instructive, and to be cordially commended, and there are parts of it that we could wish to see more widely circulated than they can be in these formidable volumes. Though disagreeing with much that it contains, the book is nevertheless to be welcomed as a timely contribution to contemporaneous inquiry, and it will unquestionably aid in giving a fresh impulse and a fruitful direction to the discussion of large and momentous subjects.

INTERNATIONAL SCIENTIFIC SERIES.
No. XLV.

MAN BEFORE METALS. By N. JOLY, Professor at the Science Faculty of Toulouse. With 148 Illustrations. New York: D. Appleton & Co. Pp. 365. Price, $1.75.

THE subject of the early history of mankind, in the light of the modern doctrine of the antiquity of man, is not only of growing interest, but in its researches and its expositions it is enlisting much of the leading talent of the age. It is established that we have to go back of all written history for that primitive basis of history which is written only in the book of nature. Here science comes to the aid of the philosophical historian, and reveals those conditions of man and society which are indispensable to the understanding of the subsequent course of humanity. Among the latest and ablest contributions to this subject is that by the eminent French authority, Professor Joly, whose contribution to the International Series is now rendered into English in a very popular form under the title of "Man before Metals." His book is an excellent compend of our present knowledge on the antiquity and early history of man, and the author's French clearness of statement has been well preserved in the translation.

In the first part of the volume, devoted to "The Antiquity of the Human Race," Professor Joly describes the discoveries that have been made in the bone-caves, the kitchen-middens of Denmark, the Sardinian Nuraghi, and on the sites of the Swiss lake-dwellings. A short chapter is devoted to "Prehistoric Man in America," but the limits of the volume forbid any detailed account of discoveries outside of Western Europe. The author disparages certain attempts to estimate the number of years that man has lived on earth, and the duration of the stone, bronze, and iron ages, and maintains that all peoples have not passed through these three ages at the same time. Hence such divisions can have only a relative, not an absolute, chronological value. That human bones are found in strata where they could not have been buried in later time, and intermingled with bones of the cave-bear, the mammoth, the reindeer, and many other long-extinct species; that the bones of these beasts often bear wounds—sometimes partly healed—which were plainly made by the weapons found in the same localities; with other evidence still more remarkable—prove that man was present in Europe during the Quaternary age. Relics have been found that have convinced some archæologists of the presence of man during the Tertiary period, and this opinion our author shares, though he does not deem the assumption proved.

Part II, "Primitive Civilization," recounts what has been learned from the relics of primitive man as regards his domestic life, methods of industry, his progress in domesticating animals, in drawing and carving, his religious ideas, and customs of human sacrifice and cannibalism. The author concludes, from the data so far obtained, that primitive European man dwelt for a considerable period in caves. The flesh of the mammoth, the great cave-bear, the horse, the aurochs, and other animals, generally eaten raw, together with wild fruits and roots, formed his staple diet. The use of fire was known, and pottery had been invented. He clothed himself in skins, which he sewed by means of bone needles. Cannibalism was practiced to some extent, and the horrors of war were already known. But, in spite of his savage customs, "he was *man* in all senses of the word—anatomically, intellectually, and morally."

On the Desert, with a Brief Review of Recent Events in Egypt. By Henry M. Field, D. D. New York: Charles Scribner's Sons. Pp. 330. Price, $2.00.

We must confess to having read Dr. Field's book with great pleasure, and found it refreshing, entertaining, and instructive. We say "confess" in honest acknowledgment of an interest hardly expected in a new book on the wanderings of the old Jews. No doubt, we were prejudiced, as Hebrew matters had been somewhat overdone in our early education. Between the horrible droning sermons, mostly about the Israelites, which made the day of rest a weariness and a burden, and the Sunday-school exercises, which were worse because sleep was impossible, and the pious books about the patriarchs and prophets, which had to be read all during the week, we got an early surfeit of things Hebraic, and when there came at length the happy liberty of reading what we liked, the children of Israel got a wide berth, and we naturally failed to keep up with the progress of modern investigation into the profane aspects of Jewish history. But early associations are omnipotent, and we have accordingly gone through Dr. Field's book describing the present aspects of ancient sacred places with an unusual degree of satisfaction.

Dr. Field's volume, we observe, has been criticised for its want of novelty. It is said that he has gone over ground that has been traversed many times before, until its interest is exhausted, and that he has not been able to add anything new or important to what previous travelers had furnished. Very likely those who have kept up with Palestine explorations and antiquarian researches into the old haunts and relics of the Jewish people would find no important revelations in this volume. But it was not intended to enlighten those who have spent their lives in the study of Jewish history. The author offers his book merely as an introduction to the learned works of those who have devoted themselves to the investigation of the subject.

He says: "The Peninsula of Sinai has been a favorite ground of Biblical explorers. In their zeal to visit scenes made dear by connection with sacred history, they have sought to follow the track of the children of Israel from the time of their departure out of Egypt; to trace their marches on the desert; to fix the place of their encampments, not only around the base of Sinai, but even when wandering and almost lost in the great and terrible wilderness. The fruit of these researches is a library of exploration, which forms a most valuable addition to our Biblical literature, not only for the knowledge it gives of sacred geography, but of the whole religious, social, and political economy of the Hebrews. While these great works, the monuments of so much learning, occupy the attention of scholars, other readers may be interested in turning over a portfolio of sketches, which claims only to present a few pictures of the desert."

From this point of view we have found the work extremely interesting. It is written in an easy and familiar style, and abounds in pleasant descriptions and common-sense reflections relating to the scenery of the country, the associations of prominent places, and the character and habits of the people that came under the author's observation. The first two chapters, devoted to Egypt and its relations to England, give an excellent summary of what is known as the "Egyptian question," and form an instructive preliminary to the subsequent chapters on the wanderings of a people so intimately associated as were the old Hebrews with the ancient Egyptians.

It was the object of our traveler to go over the ground traversed by the Hebrew people after their flight from Egypt. He accordingly crossed the desert by camel navigation, following their track, and lingering to observe the various locations that have derived their interest from the sacred history. Starting from Suez, the first point of interest reached was the wells of Moses at a mile or two on, and from this station the party pursued the route to Mount Sinai, a distance of one hundred and fifty-three miles, at the rate of twenty to twenty-five miles a day, the usual "camel's journey." After spending some time among the interesting scenes of Mount Sinai, they started through the mountains and struck into the great wilderness in which the children of Israel wandered for thirty-seven years before reaching the land of promise. The narrative then proceeds with its detail of incidents of tent-life, camping, and marching, and the description of desert scenes and memorable localities until the terrible wilderness is crossed, and the travelers emerge into the crude civilization of Palestine in the neighborhood of Gaza. From this point they proceeded through the hill country to Bethlehem, "the place where Christ was born"—a town, at present, of some five thousand inhabitants—and the chapter devoted to it is perhaps the most interesting in the book.

Of course, Dr. Field, as a good, sound, orthodox man, will not suffer his reader to suppose that he has taken this excursion from mere idle curiosity, but because of his profound religious interest in the history with which his observations are associated. The thread of narration is, therefore, once broken by an episode in which he goes into a discussion and a defense of the Hebrew polity which has been the subject of much criticism in these skeptical times. It is not so much his object to maintain the inspiration of Moses as to vindicate his wisdom and humanity as a lawgiver. His chapter on "Theocracy and Democracy," in relation to the Hebrew system of government, is readable and suggestive, but we suspect that the philosophy of the subject will not be cleared up until it is studied in the light of the great law of social evolution.

HOME GYMNASTICS; WITH A SHORT METHOD OF ACQUIRING THE ART OF SWIMMING. By T. J. HARTELIUS, M. D. Translated by C. Löfving. J. B. Lippincott & Co., Phila. Pp. 94. Price, 60 cents.

OF course, the importance of exercise to health is by no means a modern physiological discovery, but we undoubtedly owe to Ling, of Sweden, the most ingenious system of gymnastics, calculated to produce a harmonious development of the human organism, and to insure the preservation of health as well as the cure of diseases. It is said that Ling never used a movement of which he could not scientifically demonstrate the physiological effects, and there can be little doubt of the important influence it has exerted during the half-century that has elapsed since the promulgation of the "movement-cure."

The editor of this volume remarks that "it is dawning more and more upon the minds of physiologists and practitioners that 'motion is the principal agent in the whole process of life,' and that systematic muscular exercise is one of the best means for influencing the vital actions of the body." And, such being unquestionably the case, our most practical concernment is with the best means of gaining the benefit of these systematic exercises. Those who have well-equipped gymnasiums within reach may be congratulated that the problem is solved for them, but the great mass of people are without such opportunities. The little work of Dr. Hartelius, which has been so judiciously translated, is exactly what is wanted for universal home use. Systematic exercises are described and illustrated, which are suited to strengthen and develop all parts of the muscular system, and this without the use of any other apparatus than a bench, or seat, and even this is by no means indispensable. All that is required for exercise is the body itself, and as most people possess this outfit they need not be put to the slightest expense to secure a comprehensive system of gymnastic exercises, and which, moreover, shall be just as efficient as they choose to make it. Following the descriptions of movements are lists adapted for specific purposes, and for infants and old persons, as well as for those in full vigor.

The Alternative, a Study in Psychology. New York: Macmillan & Co. Pp. 387. Price, $2.75.

This anonymous work is a vigorously written polemic on metaphysics in its more modern aspects. It is written with a conservative *animus*, and the author is of opinion that he has helped forward psychological inquiry in several important particuars. Mr. Henry Sidgwick, certainly a very competent authority, says, in an advertisement to the volume: "I have had an unexpected interim of enforced cessation from my work, which I have employed in reading about half the proof-sheets you sent me. Without reading any more—which for the present I have not time to do—I feel no doubt that the book deserves the attention of all students of philosophy from the amount of vigorous, precise, and independent thinking that it contains—thinking which appears to me generally consistent, so far as it has been completely developed, though, at some important points, the work of definition and analysis does not seem to me to have been carried far enough. I also find the terse, forcible individuality of the style attractive on the whole, though I can not but wish that the author had somewhat restrained his impulse to innovate in technical terminology."

Idyls of Norway, and other Poems. By Hjalmar Hjorth Boyesen. New York: Charles Scribner's Sons. Pp. 185. Price, $1.25.

This is a collection of brief poems, some forty in number, mostly on light and fanciful subjects suited to sentimental treatment. They are of excellent literary merit, and show a skillful mastery of English versification that is certainly remarkable in an author writing in a foreign tongue. The pieces in this volume are considerably varied, both in form and in the subject chosen; we have been most struck, however, with those on "The Sea," "The Air," and on "Evolution," the latter of which we have taken the liberty of transferring to our pages. The poetic treatment of the enlarged views of nature, for which we are indebted to science, is an important part of the "progress of thought."

Aboriginal American Literature.

The second volume of Dr. D. G. Brinton's "Library of Aboriginal American Literature," is announced to appear in June. It is the "Iroquois Book of Rites," comprising the original text and a literal translation, with introduction, notes, and glossary, and is edited by Horatio Hale, Esq. This is a native composition, partly in the Mohawk and partly in the Onondaga language, and includes the proceedings observed in the council when a deceased chief is lamented and his successor is installed. The forms, after having been preserved and handed down in memory for several generations, were written down, by desire of the chiefs, when the language was first reduced to writing.

Science in Short Chapters. By W. Mattieu Williams, F. C. S. New York: Funk & Wagnalls. Pp. 308.

This volume contains a great number of brief essays, popularly written, on a wide variety of scientific subjects, and the name of the author is a sufficient guarantee of the general soundness of the information and criticism presented in the book.

The Diadem of School-Songs. By William Tillinghast. Syracuse, New York: C. W. Bardeen. Pp. 160. Price, 50 cents.

The "Diadem" is intended to facilitate instruction in sight-singing by ordinary teachers, even though they may not themselves be singers. Besides a new system of instruction arranged for this purpose, and a manual of directions for the use of teachers, it contains songs and music of varied character for all grades of schools.

PUBLICATIONS RECEIVED.

*** *Authors and others, sending papers and monographs for notice, will please specify, for general information, where they can be procured.*

Proposed Ordinance, and Rules and Regulations on Plumbing and House Drainage for Philadelphia. By the Committee of Twenty-one. Philadelphia: P. Blakiston, Son & Co. Pp. 14. 10 cents.

Report of the Director of the Illinois State Laboratory of Natural History. 1881–'82. By S. A. Forbes. Normal, Ill. Pp. 12.

The Sphingidæ of North America. By A. R. Grote, A. M. Washington, D. C. Pp. 5.

Books for the Young. Compiled by C. M. Hewins. New York: F. Leypoldt. Pp. 94. 25 cents.

University of Pennsylvania, Catalogue and Announcement, 1882–'83. Philadelphia. Pp. 116.

Entomological Papers from the "Transactions of the Iowa State Horticultural Society," 1882. Des Moines: F. M. Mills. Pp. 42.

"The American Fruit-Drier, or Pneumatic Evaporator." Waynesboro, Pa.: American Manufacturing Company. Pp. 48.

The Cornell University Register, 1882–'83. Ithaca, N. Y. Pp. 123.

The Physiology of Protoplasmic Motion. By Th. W. Engelmann, M. D. Translated by Charles S. Dolley, M. D. Rochester, N. Y.: Davis & Leyden. Pp. 40. 50 cents.

Proceedings of the Davenport (Iowa) Academy of Natural Sciences. Vol. III, Part III. Pp. 311, with Four Plates.

Lectures delivered to the Employés of the B. & O. R. R. Co. By Professor H. Newell Martin and Drs. H. Sewall, W. T. Sedgwick, and W. K. Brooks. Baltimore: B. & O. R. R. Co. Pp. 98.

The Q. P. Index Annual for 1882. Bangor, Me. Pp. 51.

The Bacteria. By T. J. Burrill, Ph. D. Springfield, Ill.: H. W. Rokker. Pp. 65. 50 cents.

Report of the United States Bureau of Statistics on Imports, Exports, Immigration, and Navigation, September 30 to December 31, 1882. Washington: Government Printing-Office. Pp. 359.

The Great Ice Age in Pennsylvania. By Professor H. Carvill Lewis. Pp. 21, with Map.

Scripture Opened. A Topical and Analytical Commentary. Acts. By Rev. J. M. Coon, Beaver Dam, Wis.

The Maintenance of Health. By J. Milner Fothergill, M. D., M. R. C. P. New York: G. P. Putnam's Sons. Pp. 366. Paper, 60 cents.

"Appalachia." April, 1883. Boston: W. B. Clarke & Carruth. Pp. 202. 50 cents.

Register of the Appalachian Mountain Club for 1883. Boston: W. B. Clarke & Carruth. Pp. 36.

The Higher Professional Life. By J. M. Da Costa, M. D. Philadelphia: J. B. Lippincott & Co. Pp. 18.

Reports of Experiments on Insects injuriously affecting the Orange-Tree and the Cotton-Plant. United States Entomological Bureau. Washington: Government Printing-Office. Pp. 62.

Reports of Observations on the Rocky Mountain Locust and the Chinch-Bug. United States Entomological Bureau. Washington: Government Printing-Office. Pp. 36.

United States Monthly Weather Review for February, 1883. Washington: Office of the Chief Signal-Officer. Pp. 52, with Maps.

Parish Institutions of Maryland. By Edward Ingle, A. B. Baltimore: Johns Hopkins University. Pp. 48. 40 cents.

Report of the Board of Commissioners of the Tenth Cincinnati Industrial Exposition. 1882. Cincinnati: James Barclay. Pp. 320.

Illustrated Art Notes of Fifty-eighth Spring Exhibition, National Academy of Design. By Charles M. Kurtz. New York: Cassell, Petter, Galpin & Co. Pp. 84. 25 cents.

A Roman Catholic Canard. Boston: "Investigator" Office. Pp. 16.

Two Great Works to be done on our Sidereal System. By Jacob Ennis. Washington, D. C.: Rudd & Detweiler. Pp. 12.

On the Action of Certain Vegetable Acids on Lead and Tin. By Francis P. Hall. Boston, Mass. Pp. 13.

Biennial Report of the Superintendent of Public Instruction of Florida. By E. K. Foster. Tallahassee, Fla.: Charles E. Dyke. Pp. 24.

Alcoholic Inebriety. By Joseph Parrish, M. D. Philadelphia: P. Blakiston. 1883. Pp. 185. $1.25.

Home Gymnastics. By Professor T. J. Hartelius, M. D. Philadelphia: J. B. Lippincott & Co. 1883. Pp. 94.

The Possibility of not Dying. By Hyland C. Kirk. New York: G. P. Putnam's Sons. Pp. 112. 75 cents.

French Forest Ordinance of 1669. With Historical Sketch of Previous Treatment of Forests in France. Compiled and translated by John C. Brown, LL.D. Edinburgh: Oliver & Boyd. Pp. 180.

The American Citizen's Manual. Part II. By Worthington C. Ford. New York: G. P. Putnam's Sons. Pp. 184. $1.

Marianella. By B. Perez Galdós. From the Spanish by Clara Bell. New York: William S. Gottsberger. Pp. 264.

Libraries and Schools. Papers selected by Samuel S. Green. New York: F. Leypoldt. Pp. 186. 50 cents.

Libraries and Readers. By William E. Foster. New York: F. Leypoldt. Pp. 136. 50 cents.

Brain-Rest. By J. Leonard Corning, M. D. New York: G. P. Putnam's Sons. Pp. 103. $1.

On Work and Wages. By Sir Thomas Brassey, K. C. B., M. P. New York: G. P. Putnam's Sons. Pp. 296. $1.

The Sciences among the Jews before and during the Middle Ages. By M. J. Schleiden, Ph. D. Baltimore: D. Binswanger & Co. Pp. 64.

Oliver Wendell Holmes, Poet, Littérateur, Scientist. By William Sloane Kennedy. Boston: S. E. Cassino & Co. Pp. 356.

Dr. B. C. Faust's Laws of Health. Translated and improved by Herman Kopp. Brooklyn: H. Kopp & Co. Pp. 37. 20 cents.

The Advanced Question-Book. By Albert P.

Southwick. Syracuse, N. Y.: C. W. Bardeen. Pp. 366. $1.50.

The Modern Sphinx, and some of her Riddles. By M. J. Savage. Boston: George H. Ellis. Pp. 160. $1.

Man before Metals. By N. Joly. New York: D. Appleton & Co. Pp. 365.

Manual of Assaying Gold, Silver, Copper, and Lead Ores. By Walter Lee Brown, B. Sc. Chicago: Jansen, McClurg & Co. Pp. 318. $1.75.

Authors and Publishers. A Manual of Suggestions for Beginners in Literature. New York: G. P. Putnam's Sons. Pp. 96. $1.

Eureka—The Mysteries of the World Mysteriously Revealed. By Asa T. Green. Cincinnati: A. G. Collins. Pp. 141.

History of Medical Economy during the Middle Ages. By George F. Fort. New York: J. W. Bouton. Pp. 488.

Life of Sir William E. Logan, Kt., First Director of the Geological Survey of Canada. By Bernard J. Harrington. Montreal: Dawson Brothers. Pp. 432.

POPULAR MISCELLANY.

How to act in a Tornado.—Sergeant John P. Finley, Signal-Service officer at Kansas City, Missouri, has published, in a pamphlet on tornadoes, some useful directions concerning the course to be taken to escape the dangers of those terrible forces. The inhabitant of a tornado-frequented district must be watchful in the season of visitations, for he can never know when the destruction will come upon him. On the first sign of the approaching vortex, he must run—always to the north, unless by going in that direction he will have to cross the entire path of the storm. If he is nearer to the southern edge than to the center of the probable path, he may go south, bearing slightly east; but in no event should he ever run directly to the east or northeast. It is impossible to save any building that may lie in the path of the tornado, or any property that can not be got out of its way. No material, no method of construction can be competent to resist the raging destruction. Nothing rising above the ground can escape it. The most practicable measure of precaution is to construct a "dug-out" at some suitable point, within easy distance from the house, to serve as a place of refuge or shelter. The retreat should be entirely under-ground, with a roof at least three feet thick, not rising above the surface of the earth, and entered from the northern or eastern side. A "cellar-cave" may be constructed from the cellar, if the house has one, to serve as a substitute for the "dug-out." It should be excavated from the west wall of the cellar, toward the west, and should be made as complete and secure as the "dug-out." If, however, the storm can not be escaped, if no refuge is at hand, or there is not time to get to it, the safest thing to do is to place one's self against the west wall of the cellar, face forward, or against the south wall, as near the southwest corner as possible. The northeast quarter is in any case a fatal position, and should always be avoided. If one is actually overtaken by the tornado, his only resource is to cast himself face downward upon the ground, with his head to the east and his arms thrown over his head to protect it. If a stump or large stone, or anything heavy that the wind will not blow over, is near, he may get a trifle of protection by throwing himself to the eastward of it. If in a house with no cellar, he should get into the west room, on the ground-floor if possible, and away from all stoves and heavy furniture. The people of towns might find it to their advantage to provide for having a watch, to be on duty on all days when the air bears the premonitory symptoms of a violent wind-storm, to give a signal to the whole population on the appearance of the first real threatening signs. The signs of the formation and approach of a tornado-cloud are distinct and sufficiently suggestive to afford opportunity for timely and concerted action. Sergeant Finley is continuing his investigations of the phenomena of tornadoes, and he has prepared three full schedules of minute inquiries calling for the facts attendant upon the appearance of the storms, which he sends to persons who were within the path of one, who were on the outer edge of the path, and who were from ten to one hundred miles from it.

Science and Faith.—"Science and Faith" was the subject of an address delivered some time ago by Professor A. J. DuBois, of the Sheffield Scientific School, before the Scientific Society of Bridgeport, Connecticut. The burden of the address is an attempt to show that the basis of all scientific knowledge is faith; that what we consider our most certain knowledge does not and can not admit of rigid demonstration, but rests at bottom upon assumptions whose truth must be taken simply upon trust. All scientific proof is really based upon the single hypothesis of the uniformity of nature—a doctrine which can never be demonstratively established, but of which the highest and strongest proof is, and always must be, merely cumulative. The evidence for this hypothesis rests upon our experience, and that is of a limited character. Thus, the foundation of our knowledge is an assumption, which, though highly probable, can not be proved. "And yet we believe: our conviction is so perfect that, even if exact and rigid demonstration were possible, it would add not one particle to the positiveness of our conviction. The fact remains, then, that we believe that which we can not prove. The scientist, no less than the theologian, rests his conclusions ultimately upon faith. When reason halts, faith steps in and leads us onward, and upon the basis of faith our most certain conclusions are founded." Reason, indeed, is our guide; but faith—that faith which, resting upon experience, nevertheless transcends experience—must be the rod and staff on which we lean. The greatest debt we owe to Science, Professor DuBois concludes, "apart from all she has done and is doing for our bodily comfort and our mental development, is for the lesson of faith she is thus ever teaching us—the lesson that Reason and Faith must ever go hand in hand . . . that man can never feel sure of attaining absolute knowledge—that pure truth is not for him; that just so surely as he walks by reason and by reason only, just so surely he must reach a point where reason halts and waits on faith."

Baron Stjerstedt's Antique Coins.—Baron A. W. Stjerstedt, who died in September, 1880, was one of the most distinguished numismatists in Sweden, and in 1857 received the grand prize of the Royal Academy of Archæology of that country for his work on the copper coinage of Sweden and its foreign possessions. He was the author of other numismatic works, and formed extensive collections of Swedish and of antique coins. The latter collection is one of unusual interest and value, not less for its completeness than for the length of time and the extent of territory it represents. Its chronological range is from about 800 B. C. to the reigns of Theodore II of Constantinople, and Manuel Comnenus of Trebizond, in the thirteenth century of the Christian era. Its geographical range comprises nearly all of the world with which the Greeks and Romans were in actual contact. Its historical continuity, although, perhaps, not unbroken, is marred by few extensive or important gaps. The department of Grecian medals includes the municipal, popular, or royal coins of cities, provinces, and states in ancient Lusitania (or Portugal), Spain, Gaul, Italy, Sarmatia, Mœsia, Thrace, Macedonia, Greece, the states of Asia Minor, Syria, Phœnicia, the Parthian kings, Ptolemaic and Roman Egypt, Numidia and Mauritania, nearly a thousand examples in all. In the Roman department are found four pieces described as "autonomous coins of Rome," consular medals, and imperial medals from Julius Cæsar to Julius Nepos, A. D. 475; while in the Byzantine department are placed the coins of the Eastern emperors, from Arcadius to Manuel—making, with a few Gothic and Vandal coins and odd pieces, 2,467 coins of Rome and its Eastern Empire. Ordinary collections are of value as curiosities or for the illustrative specimens they afford. So comprehensive a collection as that of Baron Stjerstedt may be made useful for instruction in numerous ways. It holds the thread of history with a nearly continuous series of object-lessons, and shows the relations of even the most remote points of Europe in very early times. It illustrates the growth and prevalence of myths, the vicissitudes of dynasties, and changes of religion. Some old Roman coins show Romulus and Remus suckled by the wolf. Emblems of the divine legends of the Greeks and Romans abound in hosts of pieces. Some bear contemporary portraits of men with whose names history is full; a group for Judea shows pieces of silver of the kind with which Judas was paid for his treachery; in the series for imperial Rome are shown the growth of Christianity upon paganism, the attempt to supplant it again by pagan rites, and the final triumph of the Christian emblems. In another view, the coins, for the most part still sharp and bright, illustrate the development and vicissitudes of art, from the rude efforts of archaic and provincial stampers to the finely finished medals of which those bearing the handsome features of Alexander the Great and those of the first Roman emperors may be taken as specimens. The base metal of which the coins of whole epochs were composed attests the antiquity of the dishonesty of "fiat money." The collection, which is offered for sale in this country, will be of great value to the institution that is fortunate enough to secure it.

Vegetation of the Catskill Mountain-Tops.—Professor Charles H. Peck, of the Adirondack Survey, has recorded the fact that many swamp-loving plants grow on the higher mountains of the Adirondacks, where they find the conditions of moisture suited to their growth in the frequent rains, the general prevalence of clouds, and the low temperature, all operating as obstacles to evaporation. He has found on the open summit of Mount Marcy, 5,344 feet above the sea, seven species of swamp-plants, growing five hundred feet above the tree-line, with no protection from the sun except what the vapors afford. Mr. E. P. Bicknell remarks, in his "Monograph on the Summer Birds of the Catskill Mountains" ("Transactions of the Linnæan Society of New York"), that the same fact is observable in that range, and is most strikingly illustrated by the white hellebore, which was noticed in low, damp woods in the valleys and along the streams, and growing in some profusion near the summit of Slide Mountain. "Close around the summit, too, were found, growing in abundance upon the carpeting of wet moss, plants which, at a less altitude, were rare or altogether absent, owing obviously to the scarcity of suitable swampy land. Thus, *Coptis trifolia*, which had not been noticed lower, was abundant; *Viburnum cassinoides*, elsewhere met with only in a small marsh at an elevation of about 1,900 feet, here reappeared, as well as *Viola blanda* (Willd), *Carex intumescens* (Rudge), and other plants less distinctly confined to wet and marshy situations." Mr. Bicknell also observes that in passing from the valleys into the mountains it was interesting to observe of plants of general distribution how much less advanced was their seasonal condition as the elevation increased. The extremes of this contrast, as shown by the vegetation at the summit of Slide Mountain and that of the valleys below, were most striking. Some species, which in the valleys had ceased flowering and were bearing green fruit, were still in full bloom at the mountain-tops; while others, in like condition in the valleys and on lower slopes, on the mountains had not advanced beyond their earliest buds.

Animal Revenge.—The active existence of a feeling like that of revenge and the possession of powers of memory of considerable definiteness and endurance in animals are illustrated in some anecdotes published in a recent number of "Chambers's Journal." Vixen and Viper were two dogs sent to hunt an otter. Only Vixen was able to attack the animal, and she was killed by him. Viper, who mourned for her intensely, went out in the night to hunt the otter; and the two were found on the next day clinched in death, with all the evidences of a desperate struggle around them. A Newfoundland dog was enraged by a traveler who, passing on horseback through the village, struck at him with his whip. A year afterward the traveler was passing through the same village, when the dog recognized him, and bit him through the leg. A friend of the owner of a dog, Tiger, set a stout bull-dog against him, and Tiger got the worst of the fight. He remembered the event, and watched faithfully at the neighbor's door for his opportunity. It came; the dog seized the man, and avenged his wrong. Afterward he tried to make friends with him, and to restore the relations as they had been before the offense was given. A servant-maid was accustomed to throw water upon a dog chained up during the hot weather, and for the best of motives—to cool him off. The dog, however, took the proceeding as an insult, and the first time he found himself loose sprang upon the girl and killed her. It was the duty of two dogs to take their turns at a turnspit. One of them shirked his task, slunk away, and hid. The other, when called upon to take his companion's turn as well as his own, led the people to where the truant was hid and killed him on the spot. A Newfoundland dog in Cork was annoyed by a cur. He took the animal, threw it over the dock, then plunged in himself and saved its life. Another Newfoundland dog was sent back by its master with a key which was needed at the house. It was attacked on its way by a butcher's dog, but went on about its business, paying no attention to the interruption. The key delivered, it stopped, on its way back to its master, before the butcher's shop, till the dog came out, then attacked it and killed it The story has become an old one of the elephant that cracked a cocoa-nut on the head of a man who had cracked one on its skull, and killed him. Of another elephant—and he was called "the fool,"—it is said that a quartermaster threw a tent-pin at him. A few days later, the animal came upon the quartermaster, lifted him up in his trunk, and put him in a large tree, to get down as best he could. Another elephant was treated to some nuts by a visitor who ended by giving him some so hot that they burned him. In his agony, he drank six pails of water, then threw the pail at the visitor. The two met a year afterward, when the joker offered his nuts again. The elephant ate with relish till the hot nuts appeared, then took the joker by the coat-tails and held him up till the cloth gave way and the man fell to the ground. The elephant proceeded to eat the nuts in the coat-pockets, then tore up the coat-tails and threw the pieces after the owner. The last story is of a monkey, which, being caught stealing a friar's grapes, had to wear a weight on its tail. Afterward, while the friar was performing mass at the church, the monkey climbed to the roof of his cell, and with the weight on its tail broke all the tiles.

Egyptian Funeral-Wreaths restored.—Dr. Schweinfurth writes that he has examined the wreaths which were deposited within the coffin of Aahmes I, King of Egypt, of the eighteenth dynasty, whose mummy is now in the museum at Boolak, and has found them to be composed of the flowers of the *Acacia Nilotica*, the *Nymphæa cerulea* (isolated petals), the *Alcea ficifolia*, and a *Delphinium*, or larkspur, which he supposes to be *orientale*. The wreaths of the other kings, whose mummies were associated with that of Aahmes, contained flowers of *Carthamus tinctoria* and leaves of the *Mimusops kummel*. Leaves of the watermelon were found in one of the coffins. A number of the flowers and leaves have been restored to their shape by moistening them, dipping them in alcohol, and spreading and drying them; and by this means has been obtained an herbarium of thirty-five-hundred-years-old specimens. The color of the chlorophyl, violet in the larkspur, green in the watermelon-leaf, is preserved to a remarkable degree. The Egyptian willow, of the twigs of which the framework of the wreath was composed, the *Acacia Nilotica*, and the *Nymphæa cerulea*, still grow wild in Egypt as well as in tropical Africa. The *Mimusops kummel* has been observed in modern times only in Abyssinia, while the larkspur (*Delphinium orientale*) is diffused all over the East, but is cultivated in Northern Africa as an ornamental plant. The *Carthamus* is still cultivated as a dye-plant in the East and in Egypt. Besides the wonderful preservation of delicate flowers and their colors, this "find" affords new examples of species, both wild and cultivated, which have suffered no variation during a long series of ages. Aahmes I, on whose mummy most of these flowers were found, reigned about 1800 B. C.

Insect Organs of Smell.—Gustav Hauser, of Erlangen, has made the organs of smell of insects the subject of his studies. That they are related to the antennæ is shown quite clearly by several experiments. Glass rods dipped in oil of turpentine or acetic acid, when brought near to insects, caused them to move their antennæ and turn quickly around; but, when the antennæ were cut off, the same insects showed no signs of sensation, although the substances were brought close up to them. Flies with their antennæ cut off paid no attention to putrid meat, although they had previously been strongly attracted by it. Varnishing the antennæ with paraffine was followed by a similar insensibility. Herr Hauser's conclusion is that the organs of smell of most insects consist, first, of a stout nerve proceeding from the brain-ganglion, and running along the antennæ; second, of a perceptive terminal apparatus, represented by staff-cells proceeding from the hypodermis, with which those nerves are connected; and, third, of a supplementary apparatus, composed of cavities or cones filled with a serous fluid, which may be regarded as out-foldings of the epidermis. The organs appear to be most highly developed, as would naturally be supposed, in those insects which appear to use the sense of smell in seeking for food. The greatest number of smelling cavities and cones are found among wasps and bees, the honey-bee having fourteen or fifteen thousand cavities and about two hundred cones in each antenna, the leaf-wasp a smaller number. The flesh-and-dirt flies have from sixty to a hundred and fifty organs of smell, while the flies that live on plants have only five or six cavities to each feeler.

Photographing the Corona.—Professor Huggins announces that he has succeeded in photographing the solar corona without the assistance of an eclipse. It having been shown by Professor Schuster's observations of the last eclipse that the coronal light as a whole is very strong in the region of the spectrum extending from about G to H, he conceived that by making exclusive use of this part of the spectrum, while enjoying the best possible conditions of exposure and concentration, it might be possible to take a photograph of the kind sought. He found a commercial violet (pot) glass which effected the separation required, and using this—and a potassic permanganate solution in his later experiments—with a reflecting telescope, and gelatine plates, he obtained twenty successful photographs between June and the 28th of September of last year. Captain Abney, whose experiments during the last eclipse have made him a competent judge, declares the photographs as trustworthy as any that were taken then. Professor Huggins believes that there is little doubt that under the most favorable conditions the corona may by his method be successfully photographed from day to day with a definiteness which would allow of the study of the changes which are doubtless always going on in it. By an adjustment of the times of exposure, the inner or the outer corona could be obtained as might be desired.

Cram Examinations.—"Hot-house Education" is the title of a pamphlet recently published in England, on the absurdity of the examinations in vogue there, which are systematically prepared for by cramming. Dr. Crichton Browne is authority for the statement that, by submitting boys of twelve or thirteen to the examinations, "we may be able to select those of the quickest wits, and those most susceptible of cram; but we should certainly not bring to the front those of the greatest grasp of intellect and force of character," and that to institute such examinations at such an age seems to be offering a premium on precocity. In the examinations of older candidates, tests are often exacted of a kind which an examiner who has been quoted by Mr. Froude described as setting a paper "for which Macaulay might possibly get full marks." A case is cited by Mr. Digby, the author of the pamphlet we have referred to, of an examiner who had to appeal to the Geographical Society for the answer to a problem which he had set to candidates, but could not for the time being solve himself. Another instance is that of an examiner for the army who gave out as a subject of composition, "A Visit by Sir Roger de Coverley and the 'Spectator' to Lord's Cricket-Ground." Such cases might, perhaps, be met by fixing the rule that those who make the examinations should be required to pass them.

The Right to Rest.—The London "Spectator" calls for the establishment of a new rule of etiquette, that a man who announces that he is seeking rest shall be let alone. In the hurry and strain of modern intellectual life, a necessity has arisen for periodic rest. "Overwork" is now recognized by physicians as a specific cause of disease, and a few of them are making the effects of over-cerebration, under a hundred names, a distinct specialty. The incomes of several first-class doctors in London are derived almost entirely from men whose brains are overworn, and whose nerves are so "overstrung," or "understrung," or "gone to pieces," or are "so excited," that they can neither sleep, nor work, nor remain quiet. These specialists have become abnormally discerning, and "can tell almost at a glance where anxiety has been the cause of disease, and where, as sometimes, though seldom, happens, it must be sought in actual overwork; where alcohol or drugs have assisted the decay of nervous force, and where asceticism, tried as a remedy, has seriously injured the resisting power, diminishing the fuel, till every day threatens to empty the store. They differ considerably, we are told, in their practice, some having a lingering faith in the milder narcotics, which others have lost; and some in sleep by itself, which others think is only perfectly recuperative when it comes unsought, . . . but they all agree in recommending perfect 'rest.' Their patients, who have instinct to guide them, and some memories of quick recovery during accidental or incidental lulls in life, always agree with them, but always start the question, how the rest is to be obtained." The distinguished patient can not find it anywhere in the land, for he is pursued wherever he goes by telegrams and letters, and callers, and newspaper gossip; and the only remedy, which some have heroically tried, is to go out to sea, where one can not be followed up; but this is often decidedly inconvenient. So, let the profession, and society, and the newspapers establish the rule that, when a distinguished man seeks rest for a period, he shall not be interrupted in it.

Room enough in the World yet.—Mr. R. Giffen, an English statist, has taken up the Malthusian cry that the world is filling up too fast, and has uttered his apprehension that all inhabitable countries will soon have all the population they can hold—and then what will mankind do? The "Spectator" answers him with arguments very like those which M. Fouillée has used with so much skill and effect in his articles on "Scientific Philanthropy." The laws of increase of population do not work as the Malthusians fear they will, but have ways of their own that it is hard to calculate upon. There is still, and will be for a long time, room enough in the world for all candidates for the privilege of living upon it. The United States still receives and finds homes for all who come—unless they come from China—and has a little room left. The State of New York, with five millions of population, has capacity, according to the standard that prevails in Suffolk, England, for thirty millions. The Dominion of Canada might hold fifty millions in comfort, without neighbors ever visiting each other on foot; and British Columbia has room "for twenty millions of happy people." Then, when North America is filled up, South America offers vast expanses that are not only not occupied, but are in reality not explored, of which Brazil has room for all Europe. Australia could support forty millions in its habitable belt; and Africa—who yet can begin to guess at its capacity? In the mean time, the population of Ireland is diminishing, and the failure of the French to increase excites more apprehension than any fact which is brought to the notice of their economists.

Americanitis.—Sir Charles W. Dilke, in his "Greater Britain," thought he noticed a tendency in the Caucasian native American to acquire the red Indian type of physiognomy. Mr. W. Mattieu Williams echoes this opinion, and has cited several pieces of evidence to show that a change in the direction mentioned is going on, and that it is a process of desiccation produced by the dryness of our climate. Mr. R. A. Proctor asserts that during his three visits to America he lost about thirty pounds in weight, which he recovered on returning home. Mr. Williams's own son, after residing for some time in this country, became thin, lank-jawed, and sallow, "displaying all the characteristic symptoms of what I can not refrain from calling *acute Americanitis*," but began to recover immediately after returning home. On one occasion, at the house of the late George Combe, at Edinburgh, some family portraits were brought out, including those of members who had remained at home, and photographs of members who had emigrated to America a generation before, and with them a portrait of Black Hawk. "We placed the chief on one side, the Edinburgh portraits on the other, and those of the descendants of the American emigrants between, and all agreed that the deviations from the original family type were in a direction toward that of the red Indian. Mr. Combe maintains that this is generally the case, and I agree with him in regarding the typical 'native American'—that is, the descendant of early English settlers—as displaying physically (I do not say intellectually and morally) a notable degree of reversion—or rather deviation—toward the aboriginal type displayed in the best examples of red Indians—i. e., the old fighting chiefs."

Publication of Astronomical News.—The supervision of the announcement of astronomical discoveries, which has hitherto rested with the Smithsonian Institution, has been transferred by it to the Harvard University Observatory. The first scheme for publishing news of this class in the United States was started by Professor Peters, who arranged with European astronomers for an exchange of reports with the Smithsonian Institution. The orbits of comets were published only in the German "Astronomische Nachrichten" till 1878, when their publication was begun by the Boston Scientific Society, through Mr. S. C. Chandler, in its "Science Observer." Mr. Chandler devised a new and improved code of signals for the transmission of announcements by the Atlantic cable, and engaged the co-operation of the Harvard Observatory in computing the cometary orbits. His publications in the "Science Observer" attracted attention in Europe, so that when the "Centralstelle für Astronomische Telegramme" was formed at Kiel, Prussia, in 1882, Mr. Chandler and his colleagues were made its agents for the distribution of astronomical intelligence in this country. Wishing to provide for their trust a more solid responsibility than their personalities could give it, they offered it to the Harvard Observatory, which accepted it. This act has now been ratified by the Smithsonian Institution.

Influence of Vapor on Radiation.—Professor Tyndall has published an account of some interesting experiments he has made on the variations in the radiation of heat from the earth's surface. On an elevated plateau he hung a thermometer four feet from the ground, and placed another on cotton-wool at the surface. The difference in the registry of the two instruments, that of the surface thermometer being always lowest, varied from four degrees to seventeen degrees, even when no difference was apparent in the clearness of the atmosphere. A careful review of the hygrometric conditions under which the different observations were made established the fact that the variations were dependent upon the existence or withdrawal of the check to radiation which is imposed by the presence of aqueous vapor. As a general conclusion, it may be said that, "with atmospheric conditions sensibly alike, the waste of heat from the earth varies from day to day; a result due to the action of a body which escapes the sense of vision." Similar conclusions, or the basis for forming them, are derived from the observations of Professor Soret, of Geneva, and General Strachey.

NOTES.

The Annisquam Laboratory of the Boston Society of Natural History, which has been in operation for two summers, will be open for the reception of students during the coming summer from July 1st to September 1st. It is situated on an inlet of Ipswich Bay, on the north side of Cape Ann, about three miles and a half by coach from the Eastern Railroad station at Gloucester. It is intended for persons who have already made some progress in the study; and no lectures or stated courses of instruction will be given, but suitable direction and advice. Collecting implements and row-boats are provided, and a yacht will be at hand for dredging parties. Applications may be made to Alpheus Hyatt, curator, Boston.

Professor Edmond Perrier has identified a new crinoid, the *Blastocrinus*, among the animals brought up by the Travailleur from the deep seas off the coast of Morocco. This raises the number of known living species of these most ancient animals of the sea to thirteen. The *Blastocrinus* is marked by a stem of large size supporting a calyx which is composed of five pieces, to which are fixed articulate and very mobile arms. The stem is also composed of a succession of circular articulations, placed one upon another. The radical system of this animal is very interesting. Instead of being concentrated into a single stem, it branches out into a kind of tuft, and the animal seems to have the faculty of putting out a sort of runners, like those of the strawberry.

Professor Frederic Augustus Abel, the eminent English chemist, is to receive from the Queen the honor of knighthood for his services in the War Department in relation to the chemistry of explosives, etc. Professor Lyon Playfair, F. R. S., has also received from her Majesty the honor of Knight Commandership of the Bath.

M. **Ed. Landrin** has deduced from certain experiments that the "setting" properties of hydraulic cements are due to the presence of an allotropic variety of silica which he calls hydraulic silica. He has prepared this form of silica, and has found that it has the property of forming with lime mixtures that harden under water. At the same time, while primarily it is insoluble in hydrochloric acid, it becomes when mixed with lime susceptible to its influence. He has further discovered that aluminates of lime are at least as soluble in water as gypsum, and are liable to spoil any cement in which they may be present.

Herr Josef Knörlein, the entomologist, died at Linz, February 12th, in the seventy-eighth year of his age.

A **company** has been formed and chartered to construct and work an electric railway running from Charing Cross to Waterloo, in London. The line will pass under the Thames through iron caissons. The power will be transmitted from a stationary engine to the carriages, and these will run separately, starting as filled, and occupying about three and a half minutes in the trip. A contract has been made with the Siemens Company to supply machinery and rolling-stock, and the construction of the road has been let, to be finished in eighteen months from the beginning.

The death is announced, at Basle, of Dr. Ziegler, the distinguished cartographer. He studied under Carl Ritter, and afterward established in his native town of Winterthur the cartographic establishment now conducted by Messrs. Wurster and Randegger. His most important maps are his great map of Switzerland, maps of Glarus, of St. Gall, and of the Engadine, and a hypsometric map of the world. A geological atlas and an explanatory description of the geological map of Switzerland by him are now in press.

It is estimated that the ivory which was imported into Great Britain during the nine years from 1872 to 1881 (5,286 tons) represented 296,016 pairs of tusks, and consequently a corresponding number of elephants that have been slaughtered. At this rate of destruction the elephant must in no very long time become extinct. Notice is taken in one of the reports of Mr. Webster, our consul at Sheffield, to the Government of the United States, of the small size of a large proportion of the tusks brought to the market, as indicating a wasteful destruction of young elephants. It is time, if this valuable game is to be preserved, to look for some means of checking the reckless hunting of it which is going on.

Herr Johann Spatzier, a botanist of Silesia, has recently died, at the age of seventy-seven years.

Professor P. C. **Zeller**, the distinguished Prussian entomologist, died suddenly, of heart-disease, on the 27th of March, in the seventy-sixth year of his age. He was the author of a valuable work on *Lepidoptera*, and had made important studies of American forms.

More than twelve months ago, a "perpetual" clock was started at Brussels. An up-draught is obtained in a tube or shaft by exposing it to the sun; this draught turns a fan, which winds up the weight of the clock until it reaches the top, when it actuates a brake that stops the fan, but leaves it free to start again when the weight has gone down a little. This clock was keeping good time in June, after running continuously for nine months.

M. **Pasteur's** recommendation of vaccination as a safe preventive of anthrax in sheep is contradicted by the professors in the veterinary school at Turin, who aver that, in their own experiments, they have found the vaccinated animals to be as liable as any others to be fatally attacked by the disease on inoculation. M. Pasteur has taken notice of their criticisms, and expresses the opinion that the animals they experimented with did not contract and die of anthrax, but of septicæmia, which is infallibly developed twenty-four hours after death in all animals dying of anthrax. He has offered to subject his views to a practical test, by going to Turin and experimenting with the professors, to show that vaccination, while it may not protect against septicæmia, is proof against real anthrax.

Dr. Bertillon, an eminent French statistician, died on the 3d of March last, having reached the age of sixty-one years. He is credited with having made new applications of the study of statistics, and with having been the founder of demographic science. He was also a naturalist and a close observer of animal structure and life; he paid considerable attention to botany; and has left some valuable labors in mycology. Dr. Bertillon's works in science were performed during the greater part of his life without reward. The chair of Demography in the School of Anthropology, offered him in 1876, was the first public position he held. In 1880 he was appointed by the Prefect of the Seine to the head of the Bureau of Municipal Statistics of Paris, which was founded at that time.

M. **Tacchini** has succeeded in observing the solar prominences upon the very disk of the sun. By enlarging the opening of his spectroscope, he has been able a few times to recognize on the edges of the spots these grand eruptions of hydrogen and the unknown substance helium.

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AND OF THE

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The index has been made simply a title one, as this seemed sufficient to answer all requirements. In some cases, where the title did not sufficiently indicate the subject-matter of the article, a clearer one has been substituted, the actual title being then placed in quotation-marks. Where the article is a contributed one, the name of the author follows it, and in their proper order there is given a complete list of all the authors who have appeared in the pages of the "Monthly." The departments are in all cases indicated by the appropriate abbreviation, and for convenience of reference the book notices are placed by themselves.

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CONTENTS FOR SATURDAY, MAY 5, 1883.

Lectures and Addresses.

Lectures on Human Automatism. By WILLIAM B. CARPENTER, M. D., LL. D., etc., London. Lecture IV. *Automatism in Intellectual Action.* Formation of Perceptive Judgment as a General Resultant of Previous Experience. "Common Sense" derived from like Integration of Experiences. Source of our Belief in the Reality of the External World, and in the Distinction between our Sleeping and Waking States. Ideational Automatism. Trains of Thought. Influence of Intoxicants and Morbid Poisons.

Original Communications.

Remarks on Cases of Katatonia. By WILLIAM A. HAMMOND, M. D., etc.—The Status of the Medical Profession in the State of New York. By HENRY G. PIFFARD, M. D. *Third Article.*—Some Practical Remarks on the Removal of Foreign Bodies from the Ear. By SAMUEL SEXTON, M. D.

Book Notices.

Books and Pamphlets received.

Editorials.

The New Volume from the Surgeon-General's Office.—The Association for the Advancement of the Medical Education of Women.—Sanitation in the Mississippi Valley.—The Medical Society of the State of Pennsylvania.—The Gross Professorship of Pathological Anatomy.—New York as a Medical Center.—A Choleriform Disease in Mexico.

Proceedings of Societies.

New York Surgical Society. Meetings of March 18 and 27, 1888. Strangulated Hernia. The Ovarian Corpuscle. Pirogoff's Operation. The Question of Trephining in Injuries of the Head. A Foreign Body removed from the Œsophagus. Secondary Hæmorrhage after Ligation of the Femoral Artery.

Reports on the Progress of Medicine.

Quarterly Report on Anatomy and Physiology. No. IX. By WILLIAM C. AYRES, M. D. Menstruation and Œstruation. Gautier's Poisonous Salivary Alkaloid. Automatism during Hypnotism. The Corpus Striatum.

Letters to the Editor.

A Statement. By Dr. AUSTIN FLINT, Jr.—Bellevue Hospital Medical College and the Code Question. By JOSEPH W. HOWE, M. D.

Miscellany.

The Duration of Medical Study in Germany.—Music as a Therapeutic Agent.—Rhabdo-Myoma of the Parotid Gland.—The "Nation" on the Code Question.—To the Medical Profession of the State of New York.—A Commentary on the Code Controversy.—The Philadelphia Hospital for Skin Diseases.—The Decline of Homœopathy in England.—Substitutes for Mother's Milk.—Subcutaneous Injection of Ether.—The Sanitary Institute of Great Britain.—The Salicylates and Hæmorrhages in Enteric Fever.—An International Congress of Colonial Physicians.—The Illinois Medical Law.—The Faculty of the Post-Graduate Medical School.—The Illinois State Medical Society.—Army Intelligence.—Naval Intelligence.—Society Meetings for the Coming Week, etc., etc.

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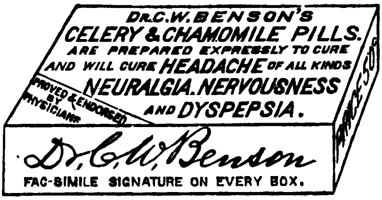
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CONTENTS.

		PAGE
I.	Matter Living and Not-Living. By Paul R. Shipman	721
II.	Homœopathy as a Science. By Edward Bayard, M. D.	732
III.	The Liver-Fluke of Sheep. By B. D. Halsted, Sc. D. (Illus.).	741
IV.	Cyclones and Tornadoes. By George Clinton Smith	748
V.	How the Earth was Peopled. II. By M. G. De Saporta	753
VI.	The Remedies of Nature.—The Alcohol-Habit. I. By Felix L. Oswald, M. D	760
VII.	The Aim of Thermo-Chemical Investigations. By J. Thomsen.	770
VIII.	The Historical Development of Modern Nursing. By Abraham Jacobi, M. D.	773
IX.	Clothing and the Atmosphere. By M. R. Radau	787
X.	The Savings of Science. By P. L. Simmonds	798
XI.	Symbiosis and "Vegetating Animals." By W. T. Sedgwick	811
XII.	The Chemistry of Cookery. By W. Mattieu Williams	818
XIII.	Some Unsolved Problems in Geology. I. By Dr. J. W. Dawson.	827
XIV.	The Colors of Flowers. By August Vogel	837
XV.	Sketch of Dr. Max von Pettenkofer. (With Portrait.)	841
XVI.	Correspondence	845
XVII.	Editor's Table: The Minneapolis Meeting.—Concerning Quackery	849
XVIII.	Literary Notices	852
XIX.	Popular Miscellany	858
XX.	Notes	863

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COMPOUND OXYGEN

FOR CHRONIC DISEASES.

CHRONIC NASAL CATARRH.

In February last a case of chronic nasal catarrh, of a very serious character, was submitted to us for treatment. In a month after commencing the use of Compound Oxygen very great improvement was reported. On the 16th of April, a month later, the father of the patient sent us the following statement of the great benefit his son had received:

"Since I wrote you last, *the change for the better is wonderful.* My son looks and acts like another boy. He says that he feels as if he were not the same that he was a month ago. All he complains of now is headache and weakness in the back, though he does not suffer one-tenth what he did before he commenced using your Oxygen. *He had not breathed through his nostrils to do any good for two years; now he can breathe freely.* The sense of smelling was almost destroyed; it is gradually returning now. *I can not find words to express my feelings of gratefulness for the returning health of my son.* Our neighbors all see the change and speak of it."

No treatment known to the medical profession can cure a case of nasal catarrh which has progressed as far as this one, and as for the various advertised methods of treatment by the inhalation of crude drug vapors or the injection of medicated solutions, by which the irritated and sensitive mucous membranes are still further injured, they only make the disease worse. There may be a temporary relief because of deadened sensibility from acrid drugs, but in the end the remedy will be found to have been worse than the disease.

In Compound Oxygen, which regenerates the blood and gives to the system a new vitality, and thus enables it to throw off the impurities which have been poisoning life at the very fountains, we have the only sure, safe, and rational means of cure yet discovered. Some of the worst cases of nasal catarrh which we have ever seen have been cured by Compound Oxygen.

HÆMORRHAGE FROM THE LUNGS.

The following letter, addressed to Dr. Turner, who has charge of our depository, at No. 862 Broadway, New York, is commended to all who are suffering from hæmorrhages from the lungs. It is only one of many cases in which bleeding from the lungs has been almost immediately arrested by Compound Oxygen, and its recurrence prevented.

"334 W. ELEVENTH STREET, NEW YORK CITY,
May 10, 1883.

"Dr. JOHN TURNER: *Dear Sir:* As I am very thankful and grateful for the results of the 'Compound Oxygen,' I think it right that I should give you some record of my case.

"I have been using the 'Compound Oxygen' from your office since January 27th last, and am now able to go out every day for an hour or two, which I have not been for nine months past. I was taken with what the doctors called bronchial congestion of the lungs, *with severe and continued hæmorrhages of the lungs, which lasted from two to three days at a time.* These hæmorrhages commenced in July, 1882, and lasted until January, 1883, and of course I was utterly prostrated for weeks after.

"*I have had no hæmorrhages since I commenced to take the 'Oxygen' in January last.* I have been under the care of many doctors, but all considered my case hopeless.

"I was examined by Professors L—— and W——, and also by Dr. E——, and up to the middle of March last they all regarded my case as *hopeless.*

"At present I have about given up all medicines and rely upon the 'Compound Oxygen' alone. I am now on the second supply of the 'Compound Oxygen,' and *consider myself well on to a complete cure.*

"L. F. CLARK."

BREAKING UP COLDS.

If the action of our Treatment never went further than to arrest and break up colds, it would be one of the greatest boons to humanity. Nearly all acute diseases which run swiftly to a fatal termination have their origin in colds. We have no hesitation in declaring that, if Compound Oxygen were resorted to immediately on discovering that a cold had been taken and was centering itself on the chest, deaths from pneumonia would be of rare occurrence. The results which have followed the use of our Treatment in hundreds of cases warrant us in making this strong declaration, and we would be lacking in duty to the public were we not to make known as widely as possible an easy and almost certain means of preventing the development of this often fatal disease, and of other diseases, which, if not checked, slowly undermine the health and shorten life.

From a letter received last February from a lady in Salem, Mass., we take the following, in evidence of the prompt action of Compound Oxygen in cases of colds:

"When I last reported, *I had a very severe cold,* and two days afterward *I had pains in the front part of the right lung half of one day, which the Compound Oxygen promptly removed.* After that I steadily improved; appetite returned as before the cold, and it is now better than it has been since using your Treatment. . . .

"*During the use of the first Treatment I hardly knew what it was to feel tired.* A friend, who is often at our house, said, one day, 'I have not seen you look or act tired once since you used the Compound Oxygen,' to which I replied, 'I have not, and go up-stairs as briskly at 3.30 P. M. as I go down in the morning at 6.30.'

"I am quite well satisfied with what the Oxygen has done for me this winter, for *I never did less coughing; the colds have been diminished at least one-half in severity;* appetite vastly superior to what it has been at other similar seasons, and respiration improved. *I have also broken up two severe colds for my youngest boy,* a lad of sixteen, who always has had an inflamed throat and fearful cough. *I do not think he has coughed once this winter.*"

A lady writing from Mifflinburg, Pa., says:

"My health is so much better that I can do my own work, and am able to attend church every Sabbath and go to evening entertainments, etc., which I never expected to do. Have been using Compound Oxygen, for *severe colds,* on my boys this winter, *and it has acted like a charm.* I feel very grateful for what the Compound Oxygen has done in my case."

Another patient says, in a letter dated last March:

"My general health is good; *while all around me are suffering from colds, I have escaped having any, and this is the first winter since I can remember that I have not had a severe cold,* ending with a cough that always lasted several weeks. This I attribute to the use of Compound Oxygen, as I have used no other preventive."

Our Treatise on Compound Oxygen *is sent free of charge.* It contains a history of the discovery, nature, and action of this new remedy, and a record of many of the remarkable results which have so far attended its use.

DEPOSITORY IN NEW YORK.—Dr. John Turner, 862 Broadway, who has charge of our Depository in New York city, will fill orders for the Compound Oxygen Treatment, and may be consulted by letter or in person.

DEPOSITORY ON PACIFIC COAST.—H. E. Mathews, 606 Montgomery Street, San Francisco, California, will fill orders for the Compound Oxygen Treatment on Pacific Coast.

Drs. STARKEY & PALEN

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G. R. STARKEY, A. M., M. D.
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MAX VON PETTENKOFER.

THE
POPULAR SCIENCE
MONTHLY.

OCTOBER, 1883.

MATTER LIVING AND NOT-LIVING.

By PAUL R. SHIPMAN.

THE Victoria Institute, or Philosophical Society of Great Britain, has published, in pamphlet form, a paper by Professor Lionel S. Beale, in which that eminent physician and microscopist attacks, with free assertion and aspersion, the doctrine of the identity of living and not-living matter. Dr. Beale is himself a member of the Victoria Institute, and, if one may judge from the *imprimatur* which the society has set on his paper, he is esteemed a spokesman worthy of its name, if not a foeman worthy of anybody's steel; and no doubt the paper has proved acceptable to those for whom it was intended. It may be worth while, therefore, in the interest especially of this excellent class, to examine what he has to say.

Dr. Beale, it might better be mentioned at once, has a theory of his own, or at least of his adoption, with which he confronts the theory of his aversion; and it will conduce to clearness, as well as brevity, if we first look at the opposing theories side by side, premising that Dr. Beale expressly lays the question of their relative merits before the tribunal of science, whose jurisdiction in the case he thereby acknowledges. Let us at the outset, then, regard the two theories as he sets them face to face.

Dr. Beale opens the discussion by confessing that he finds himself among the "very small number" who "have objected to the physical view of life as untenable *in the present state of scientific knowledge*," a qualification which in the course of his paper he repeats and reiterates, and which means, if it means anything, that the capacity of physical causes in this relation has not yet been explored exhaustively, and that the view in question may become tenable in the progress of scientific knowledge. "The living world," Dr. Beale proceeds to say, in the face of this significant admission, "is absolutely distinct from the non-living world, and, instead of being a necessary outcome of it, is, compared with the antiquity of matter, probably a very recent addition to it—not, of course, an addition of mere transformed or modified matter and energy, but of transcendent power conferred on matter, by which both matter and its forces are controlled, regulated, and arranged, according, it may be, to laws, but not the laws of inert matter." This additional agent is, of course, our old acquaintance—the *vital force.* Dr. Beale adds: "It may be freely admitted that, if we attribute to vital power certain phenomena of the living world which have not been, and can not be, explained or accounted for by any physical laws yet discovered, we thereby assume an agency which we are unable to isolate or demonstrate, and the existence of which we can not in any way prove. On the other hand, it is only fair to observe that, if we assume that phenomena peculiar to life will some day be explained by physics, we certainly act in a manner which is not sanctioned by science—we assume, we prophesy; and prophetic assumptions of every kind are contrary to the spirit of science. . . . But is it not in accordance with reason," he concludes, "to assume the existence of a peculiar power to account for phenomena which are peculiar to living beings, which differ totally from any known physical phenomena, and which can not be imitated—and is it not contrary to reason to prophesy that such phenomena will one day be explained by ordinary forces or powers?" Such is his statement of the case, and such the argument by which he supports his side of it.

A few words, I think, will suffice to show the invalidity of the argument. The question, fortunately, hinges on a point which science has determined definitively.

A genuine hypothesis, in the scientific sense, is capable of proof or disproof; for an hypothesis capable of neither must always remain an hypothesis, and, instead of leading to an explanation of phenomena, serves to block the way to it. I may say here, parenthetically, that too much verbal respect, as it seems to me, is usually paid by scientific thinkers to assertions of this transcendent sort; strictly speaking, an assertion, of which it is said that it can be "neither proved nor disproved," is disproved by denying it, for the denial, being of equal validity with the assertion, nullifies it, leaving zero as the logical result, and an assertion reduced to zero is effectually disproved. But to return. An unverifiable hypothesis, as incompetent to lead to certainty, has no reason of being; and, consequently, science pronounces it illegitimate. But the hypothesis of a *vital force,* Dr. Beale admits, is unverifiable. It assumes "an agency," he owns, "which we are unable to isolate or demonstrate, *and the existence of which we can not in any way prove.*" It is, therefore, illegitimate on his own showing.

Moreover, a genuinely scientific hypothesis does not assume an unknown cause, much less an unknowable one, before the inadequacy of known causes has been proved, for, till then, the necessity of an additional cause can not appear. The maxim which imposes this condition on hypotheses, known in philosophical literature as Occam's razor, is declared by Sir William Hamilton, who calls it the law of Parcimony, to be "the most important maxim in the regulation of philosophical procedure, when it is necessary to resort to an hypothesis." Its soundness is questioned by no one. But Dr. Beale, as we have seen, admits by plain implication, repeatedly, that known causes have not yet been proved inadequate to explain the phenomena of life. His cautious statement is that they are inadequate "*in the present state of scientific knowledge.*" Wherefore, as he must also admit, his assumption of a hyperphysical agent violates flatly the law of Parcimony; it falls under the first stroke of Occam's razor. It is thus doubly illegitimate, on his own showing.

Finally, the hypothesis, if admitted, would not explain the phenomena, since it merely refers them to a power of which confessedly we can know neither the existence nor the laws, assuming to explain that which we do not know now by that which we can never know or so much as represent in thought; and it goes without saying that an hypothesis which explains nothing is good for nothing. In branding it with illegitimacy, science but renews the stigma that common sense had set on it.

The hypothesis, it follows, has no standing in the court of science, which rules it out at the threshold; and to the court of science, be it remembered, Dr. Beale has appealed. One thing, then, is certain: whatever may be the merits or demerits of the hypothesis which he opposes, the hypothesis which he espouses has no merits at all. It is radically vicious, and wholly inadmissible. So far from being "in accordance with reason," it is in flagrant defiance of it.

It remains to inquire into the remaining hypothesis. If we may credit Dr. Beale, it is as spurious as his own. "If we assume," he tells us, "that phenomena peculiar to life will some day be explained by physics, we certainly act in a manner which is not sanctioned by science—we assume, we prophesy; and prophetic assumptions of every kind are contrary to the spirit of science." That depends on the character of the assumptions. If, like his hypothesis, they are incapable of proof or disproof, besides gratuitously multiplying causes, and explaining nothing after all, they undoubtedly are contrary not only to the spirit but to the letter of science; but, if they fulfill the conditions of a legitimate hypothesis, in lieu of violating them at all points, as his own assumption does, they as undoubtedly are in strict harmony with science. It would be passing strange if they were not. If "prophetic assumptions of every kind" were in truth "contrary to the spirit of science," that "star-eyed" creature would be more contrary than the privilege of her sex allows, for it is by "prophetic assumptions" that she has won her chief triumphs, nearly everything which is now certainty having once been assumption. When Copernicus divined that the planets revolve around the sun; when Kepler suggested that the planetary orbits are ellipses; when Newton proposed the law of gravitation, and, later, the identity of gravitation with the central force of the solar system; when Huygens conjectured that light is propagated by undulations; when Harvey, in the profession of which Dr. Beale is an ornament, supposed that the blood flows from the left side of the heart into the right through the arteries and veins; when Locke asserted that heat is motion; when Franklin assumed that lightning and electricity are one; when Dalton affirmed that elements combine in definite, reciprocal, and multiple proportions; when Leverrier announced the existence and position of a planet outside the orbit of Uranus; when Faraday conceived the principle of definite electro-chemical decomposition—they each and all indulged in what were "prophetic assumptions," until in due time the assumptions were proved and the prophecy accomplished. And so, for the most part, with the rest. Wherever, indeed, there is an inquisitor of nature, whether observer or experimenter, there is likely to stand behind him some hypothesis, more or less shifting, more or less defined, more or less probable, which guides his inquiries and shapes their results; and what is generally true of the experimental sciences is true in greater degree of the sciences in which experiment is impossible or possible only within a narrow range, such as astronomy, biology, psychology, sociology. The truth is, without "prophetic assumptions," science would need either omnipotent insight, to see through every problem at once, or that omnipotent blindness which enables its happy possessor to solve every problem, as Dr. Beale would solve the problem of life, by referring it out of hand to some agency beyond the bounds of human knowledge; but, as science is endowed with neither, it has, in general, no other course, certainly no better course, than to proceed tentatively by "prophetic assumptions," careful only, though rigorously careful, that these shall fulfill the acknowledged conditions of a legitimate hypothesis. As for such "assumptions" as Dr. Beale's, they are not "prophetic," it is true, but only because they forever renounce the hope of explanation. Science rejects them, as we have seen.

Let us see whether or not the hypothesis of the evolution of living from not-living matter encounters the same fate.

To begin with, the hypothesis, it will not be denied, is verifiable, for it assumes only a certain competency in the properties of matter, which, if it exists, is capable of proof under possible conditions, and, if it does not exist, is capable in like manner of disproof; so that in the end the assumption must lead to certainty or step down and out. Such being the case, it fulfills the first condition of a legitimate hypothesis.

The hypothesis, in the next place, assumes no special cause, known or unknown, physical or hyperphysical, but accepts that which, by universal consent, is not only the cause of inorganic phenomena, but the invariable concomitant, if not the cause, of the phenomena of life. It does not multiply causes with or without necessity, and hence is philosophically clear and clean. Occam's razor may pass over and around it without meeting with a pilous stub.

And, lastly, inasmuch as the assigned cause is real, and as the final verification of the hypothesis must consist in deducing the phenomena from it, the hypothesis, when verified, will of necessity explain the phenomena not merely in their completeness, but to the exclusion of all other explanations. It is one of those fortunate cases, not too common in the history of science, wherein the explanation of the phenomena is the demonstration of the hypothesis.

In the judgment of science, therefore, the hypothesis as such is without spot or flaw. So far from being "contrary to reason," it is in perfect accord with it.

From all of which it appears that the converse of Dr. Beale's opinion of the two hypotheses is true. His terms of praise and dispraise were well chosen, but, as it turns out, he mixed them badly before applying them. So much for the opposing theories as theories.

Having seen that, from the scientific point of view, the hypothesis which Dr. Beale espouses is thoroughly illegitimate, and that the hypothesis which he opposes is thoroughly legitimate, we have now to look at the existing evidence in support of the latter; and here we shall strike Dr. Beale's criticisms, for here their incidence logically falls. With how much force they fall we shall presently see.

When two series of phenomena shade off into each other by insensible gradations, the philosophical presumption is that both series have been generated by one cause; and it behooves him who would overcome this presumption to draw the line of demarkation between the series, and prove that the phenomena on the opposite sides are so different that they could not have had a common origin. Organic and inorganic phenomena, I need not say, thus shade off into each other; but no one has been able, though many have made the attempt, to draw a line of absolute demarkation between them, much less to prove that the two series, as arbitrarily distinguished from each other, must have proceeded from different causes. Toward the proof of this the first step has not been taken, and it is safe to say that it never will be; it is barred by the indissoluble continuity of natural law. Meantime the presumption stands in more than its original strength.

A kindred presumption, throwing a kindred burden on the shoulders of whoever would rebut it, is the presumption that causes which increase an aggregate are competent to originate it. The forces which determine the growth of a crystal, to exemplify, are the forces which produce its embryo; and the like holds true of all other aggregates below the vital ones. Why not of these also? The forces which determine the growth of a plant or animal are physical forces; any assumption to the contrary, remember, even Dr. Beale avows that "we can not in any way prove." Why can not physical forces, in this case as in others, originate what they develop? It is for him who denies that they can do both or either to show why. This has never been done; and, till that which Dr. Beale admits to be unprovable is proved, never will be. The denial is a bald negation, leaving the presumption to stand, like the allied one, strengthened by a fruitless contradiction.

But we are not left to philosophical presumptions, insurmountable though they are. The evolution of living from not-living matter, it should be borne in mind, is an essential part of the hypothesis of evolution at large, and shares evenly in all the evidence, direct and indirect, which supports the general hypothesis, and which, against rooted predispositions of every kind, and amid the continual uproar of detraction and abuse, has revolutionized the thought of our time, putting Dr. Beale and his school of thinkers, but lately in an overwhelming majority, in a minority that he fairly terms a "very small number," and taking the chair of authority, as he ruefully complains, not simply in the laboratory and the closet, but in the study and the school, and, he might have added by "prophetic assumption," the Church, that loving mother of most of us beginning dimly to perceive that evolution founds science and religion on the self-same basis, and, in place of being the enemy of either, is the truest friend of both. The evidence which, in the course of a single generation, has wrought this marvelous change in unwilling minds, and the more distinctly in the higher minds, goes in its full strength, I repeat, to support the special hypothesis in hand. Manifestly, the leaders of thought, in both hemispheres, estimate this evidence differently from Dr. Beale. It is truly irresistible to an open and enlightened mind.

Furthermore, the earth, we should not forget, is her own biographer; and in the geologic chapter of her authentic sketch is recorded a time when life did not exist within her limits. Life on the earth had a beginning, then. This is not denied. Nor is it denied that up to the beginning of life all terrestrial phenomena were the effects of physical forces.

So much is conceded by every one, Dr. Beale not excepted. And, now came life. Whence did it come? Whence does it come? Physical forces, undeniably, are the constant antecedents of life; which, moreover, varies in fixed correspondence with determinate variations in them. This Dr. Beale must likewise concede, or assail the foundations of his art. But it is an axiom in scientific inquiry that anything, upon whose variations the variations of an effect are uniformly consequent, is the cause or connected with the cause of that effect; and, since the physical forces accompanying life are connected with no other cause except the Ultimate Cause, it results that they are the proximate cause of life—the only cause, that is to say, which the human intellect can grasp, and with which accordingly science has to reckon. If we reject this conclusion, we reject with it the methods of science, and along with these science itself. But science is our chosen arbiter.

Nothing in reality is lacking to crown the hypothesis with demonstrative proof but to discover the law of co-operation of the physical factors uniting in the production of life, and deduce the phenomena from it; although to furnish this may well tax the highest resources of science for an indefinite future. And yet some happy feat of induction or deduction, or of both combined, may furnish it to-morrow. Meanwhile, the hypothesis as it stands, it is hardly too much to say, exacts the acquiescence, if it does not secure the assent, of every mind at once unbiased and not uninformed. The cause of life is known. The law of the cause alone is unknown. This law, as to which no hypothesis has yet been formulated, is strictly the only aspect of the subject open to hypothesis; so that, while the hypothesis supplied has passed beyond the hypothetical stage, the hypothesis required has not definitely reached it. In this logical interregnum, however, the vacating hypothesis, obviously, must still rule the discussion. But let us hear Dr. Beale.

"Bear in mind," he admonishes us, "that no state of matter known, no mere chemical combinations, no mechanical contrivances, no machinery ever made, can be caused to exhibit phenomena resembling in any really essential particular those which are characteristic of every form of living matter that exists in nature." This admonition may be just, and I am disposed to think it is, if qualified by that reference to "the present state of scientific knowledge" which the learned professor often makes, but which he here apparently fails to "bear in mind"; yet, with this qualification, it is not indisputably just, seeing that Dr. Bastian, one of the foremost experimenters of the age, contends that he has surmounted the difficulty which Dr. Beale declares to be an impossibility. Whether Dr. Bastian has achieved this result or not, the impossibility of achieving it has not been proved; on the contrary, the possibility, with the advance of scientific knowledge, has grown clearer. A few years ago, Dr. Beale might, with equal justness, have delivered this same admonition to us in respect to organic compounds of every sort; but meanwhile chemistry, in the face of the assumed impossibility of making any of them, has, in fact, made hundreds of them, therein surpassing the creative power even of animal life, which in general is powerless to form them, but appropriates them ready made from the vegetable world, in which they are compounded out of their elements; and, if chemistry can produce organic matter, it may, when further developed, produce organisms, or, what would be of equal significance, formless protoplasm. It is on the way, and pressing forward. While impossibilities, akin to Dr. Beale's present impossibility, are falling right and left under the strokes of science, who shall say that this one, too, may not ultimately crumble beneath the strenuous but reverent assault? Whether the achievement is possible or impossible, however, the derivation of life from not-life at some time, if not at this time, under conditions provided in the laboratory of Nature herself, is certain: the fate of the hypothesis is not by any means involved in that of the experiment.

"No specimen of any kind of matter which is actually passing from the non-living to the living state, or which can be shown to establish any connection between these absolutely different conditions of matter," Dr. Beale asserts, "has been, or can be at this time, brought forward." Discounting the expression "absolutely different," and noting with satisfaction the qualifying phrase "at this time," it must be observed that the assertion remains, nevertheless, in some degree inaccurate. Not to mention that all living matter is constituted by not-living elements, there is good reason to believe that the molecules of those colloidal compounds which together form living matter are constituted by molecules of the not-living crystalloids, and it is beyond dispute that the same substance, as silica, may pass, under varying conditions, from the crystalloidal to the colloidal state and back again, for which reasons, among others, the colloid may be pointed to as a "kind of matter" which, if not "actually passing from the non-living to the living state," can at least be said to "establish" some "connection" between these "different conditions of matter." Be this as it may, it "has been brought forward" as such, and by no less honored an investigator than Professor Graham, whose discovery of the law of the diffusion of gases, to say nothing of his profound researches on the diffusion of aqueous solutions, should have made his name familiar to Dr. Beale. "The colloid is in fact," says Professor Graham, "a dynamical state of matter, the crystalloidal being the statical condition. The colloid possesses *energia.* It may be looked upon as the primary source of the force appearing in the phenomena of vitality." Whatever Dr. Beale may think of the colloid, it serves at any rate to check his broad assertion, and at the same time to indicate how sharply experimental science is pressing upon the problem of life. "At this time," however, the pregnant movement has but fairly begun.

"But the fact," Dr. Beale insists, "that this living matter, as is well known, is invariably derived from matter that already lived, is a serious difficulty which presents itself to the mind at the outset of the inquiry." Here, again, our professor omits the important qualification to which he is committed. "Living matter" is "invariably derived from matter that already lived," so far as our experience goes, if we leave out of the account Dr. Bastian's experiments; but our experience at present, aside from those interesting but unfinished researches, does not stretch away to the beginning of life, and it is unphilosophical to extend a merely empirical law beyond the limits in which it has been found true by observation. It was once believed, for instance, that all swans are white, and, what is more, the belief was sustained by the uniform experience of mankind for thirty centuries; but it turned out to be erroneous, all the same. That the black swan of *archebiosis* has not been seen is no proof that it may not be seen, if we push on to its presumptive haunt by the shaded springs of life; and, in the interval, we can be sure only of what we have positively seen. But of this there of course can be no doubt. The famous maxim, *All life proceeds from life*, is indeed necessarily true of all the more specialized forms of life, because the proceeding of any one of these directly from inorganic matter would necessitate a leap over the intermediate forms; and Nature, as in our day is realized more vividly than before, does nothing by leaps. The maxim, though reached inductively, may be explained deductively; it is itself, thus limited, a corollary from the general law of evolution. But, with forms of life having little or no specialization, and only a few removes or one remove from inorganic matter, the case is plainly different. Respecting these, induction, so far as it has yet gone, and deduction, so far as it can now be applied, agree in pointing unmistakably to their origin in the unorganized matter from which they are scarcely distinguishable, and from which they differ in every respect vastly less than from the more specialized forms arising out of them, and immeasurably less than the human adult differs from the human embryo. Of these lowest forms, exhibiting life almost or quite without organization, the maxim not only is not necessarily true, but is necessarily untrue. It applies, as it must ever apply, to living things in general, but not to those living things which exemplify the bottom characteristics of the group. *Omne vivum ex vivo* was not written of the type. If it were, *ex nihilo nihil fit* could not be written too.

"According to the material contention," avers Dr. Beale, "everything owes its existence to the properties of the material particles out of which it is constructed." Whereupon he rather scornfully asks, "Who would think of asserting that in the properties of brass and iron or steel we shall find the explanation of the construction of a watch?" Nobody; with this interrogatory Dr. Beale knocks over a man of straw set up with his own hands. What he calls "the material contention" is really that every phenomenon owes its existence to the properties of matter; but this contention his crucial instance does not meet, for denying that a watch owes its existence to "the properties of brass and iron or steel" is not denying that it owes its existence to material properties, acting under special conditions, in special combinations, according to special laws, and emerging into a special organism, with the capability of watch-making: he answers what is asserted by denying what is not asserted. The fallacy, however, may suggest the clew to a better comprehension of the reality. Why do not "brass and iron or steel" manifest the phenomena of watch-making? For essentially the same reason that primitive man did not manifest them: because in these metals, as in primitive man in an immensely less degree, the synthesis of forces is too simple and unevolved, it being a law of matter that every state of material forces not only is derived from preceding states, and manifests phenomena peculiar to itself, but that the more complex and evolved the state, the more complex and evolved the phenomena. In this law, speaking broadly, we have a key to the source of life. Oxygen, hydrogen, carbon, and nitrogen, uncombined, present, for example, one state of material forces, which manifests one set of phenomena; water, formed by the combination of oxygen and hydrogen, is another state, less simple, and manifesting less simple phenomena; alcohol, resulting from the union of oxygen, hydrogen, and carbon, is another state, more complex, and manifesting more complex phenomena; carbonate of ammonia, consisting of oxygen, hydrogen, carbon, and nitrogen, is another state, more complex still, and manifesting phenomena of corresponding complexity; and protoplasm, containing the same elements as carbonate of ammonia, but united in higher multiples, and uniting under conditions unknown though not unknowable, is simply another state, more complex than any of the others, and manifesting the phenomena of life, which, it deserves to be noted, are no more peculiar to life than the phenomena of alcohol are peculiar to alcohol, or the phenomena of water peculiar to water. The peculiarity is the peculiarity of every state alike, as could hardly be otherwise, unless a thing could be itself and at the same time something else.

In the lower states of matter this law offers no difficulty; but, as the successive states become more and more removed from the elementary state, exhibiting phenomena more and more removed from the elementary phenomena, it grows, first indistinct, next unperceived, then unimagined, till at length, culminating in life and mind, it eludes definite conception in the bewildering complexity of the phenomena, and its consummate product, puffed up by the height to which it has raised him, turns round and disowns it altogether, perversely kicking over the ladder by which he ascended, and proudly asserting his right to pose upon nothing. Yet the law is none the less operative at every stage, from nebula to consciousness, and in itself is as comprehensible in the last stage as in the first. That one synthesis of forces should issue in life is at bottom not more wonderful than that another synthesis should issue in water. The two manifestations are equally comprehensible up to a certain point, beyond which they are equally incomprehensible, a mystic chasm, soundless yet crossed by a step, bounding equally every atom of the wide universe; only, in so simple a thing as water, the step whereby we cross this ever-recurring interval need not be often repeated, and the approach is comparatively open, whereas, in life, to say nothing of mind, the step is to be taken such countless times, in such countless directions, within such countless chambers, passages, recesses, that no wonder the broadest and loftiest intellect of our time, or of any time, stood baffled at the threshold of the labyrinth until he had fashioned the clew of Evolution to guide him through its windings; but the step, though infinitely multiplied, is one and the same, spanning eyer the same fathomless chasm, and the faculties which enable us to take it once render us competent to repeat it indefinitely. We thread the maze by a developed use of the powers by which we enter it, treading always over, but never into, the meshes of infinity. The real difficulty, as already implied, is that our present knowledge and intellectual training do not match the complexity of the higher phenomena, which, notwithstanding their astounding complexity, differ from the lower only as a problem in the calculus differs from a sum in addition and subtraction. Fundamentally, there is no difference in the phenomena, and no break: all are interconnected by one unbroken chain of causation. As the watch-maker is developed from primitive man, so is life developed from primitive matter, and the gap between these is no more impassable and no less than the gap between those, or, for that matter, than between the simplest compound and its elements, or between the atoms of the elements themselves. The interval in every case is essentially identical. If it makes life mysterious, it makes mysterious every other thread in the texture of things. The mystery is the same throughout; and so is the only explanation with which the wit of man can embroider the somber secret.

Dr. Beale has nothing more to say with which we need concern ourselves. He is, as I have said, a physician of eminence, and, I may add, a microscopic observer of approved accuracy; but as a philosophical critic he is not a success. I have treated him with courtesy, out of respect for the proprieties of serious discussion rather than for his deserts. The tone of his paper is not candid or respectful; its spirit is derisive; and the body of it is composed chiefly of a tirade, not conspicuous for judgment or comprehension, against the decay of modern thought and the dogmatism of modern scientists, among whom he generously singles out Professor Huxley as a scape-goat, and, laying both hands on his laureled head, confesses over him, with much unction but no fair words, all the iniquities of the children of light, and halloos him, crowned with the shining burden, into a land not inhabited by members of the Victoria Institute. But all this I pass by. It is tempting, I confess, but space or the lack of it, if nothing better, delivers me from the temptation. On the title-page of Dr. Beale's pamphlet is inscribed: "The New Materialism; Dictatorial Scientific Utterances, and the Decline of Thought." Of this inscription the first part might stand, fitly enough, for the title proper, and the last part for the characteristics of the paper, were it not that its "dictatorial utterances" happen not to be "scientific," and that its "thought" exhibits not so much "decline" as destitution. However, I am not inclined to deal severely with the distinguished professor, and accordingly content myself with flinging back the title-page into his teeth.

HOMŒOPATHY AS A SCIENCE.

BY EDWARD BAYARD, M. D.

"Philosophy and science are so related as to constitute a unity."—"The Relations of Mind and Brain," CALDERWOOD.

MANY of the most important discoveries of the psychologists were rejected by the physiologists, because they could not be proved by their law—and conversely with the psychologists. These contending forces have been brought into lasting alliance by Professor Calderwood. It is believed that as close a relation can be established between Nature's laws and those of homœopathy.

Vaccination, as the sole and sure preventive of small-pox, is one of the great, dominant, fixed facts of the old school. Here is the open and avowed application of the law of cure by similars, *similia similibus curantur*. If it be a law of cure in one case, by what logical process can it be demonstrated to fail in all others? Those most conversant with Nature's laws assert, and truly, that she makes no exceptions: the law of gravity; that water seeks its own level; that the pressure of water is equal in all directions; that sound ascends; that heat expands. It was this universality of the law of Nature which enabled the great naturalist, Cuvier, to construct a whole skeleton from two or three bones. So, with equal certainty, if necessary, could the skeleton of the homœopathic law be evolved from this single bone of its structure—vaccination. Starting from different stand-points, the old and new schools have progressed in the same direction, to diminished doses, both in size and repetition. This is concededly due in the old school to the influence of homœopathy, in the new it is the growth of its own experience.

Messrs. Bell and Laird, in their admirable monograph on diarrhœa, say: "There is indeed a somewhat prevalent opinion that the strength of the dose makes up for want of due care or knowledge in selection. This may be stated in mathematical terms, as follows: If the thirtieth potency of arsenic is equal to a complete knowledge of the drug, one fifth of a grain of arsenious acid is equal to complete ignorance of it. Stated in this, its true form, we grant it."

Homœopathy, as a science, is the law of the vital force; the body is but the mechanism upon which it operates. The dissecting-knife has laid bare to the astonished gaze of the student a perfect organism, while the operating-table presents the companion picture of an organism in total ruins dominated by the vital principle. What, then, is disease—typhoid, pneumonia, scarlet fever? No; disease is the impairment of the equalization of the vital force, and it finds expression where the organism is weakest.

What is cure—to take physic for typhoid or scarlet fever? No; to cure is to locate the center of the disturbance, the diseased nerve-cell, and restore the equilibrium.

How do you do this? In spite of its many ramifying influences, the nerve-cell preserves, to the close and exact student, its individuality, often veiled under the apparently familiar features of others, but still recognizable by the differentiating mind. It is this similar of state and remedy which the homœopathic physician, who knows and applies the law, seeks in the patient and in the materia medica; when found, the means of restoring the equalization of the vital current is found with it.

As there is but one nerve-center of a disease, so is there but one remedy.

The system has always a tendency to resist, by reaction, the morbific cause which disturbs it. The similar stimulates reaction. When you put your hot hand into hot water, and take it out and wipe it dry, by the law of reaction it becomes cool. So, if to the frost-bitten ear or hand you apply snow or ice, by the law of reaction the frozen part burns under its stimulus. The power of resistance, which is reaction, is the strength of the constitution, or is the constitution itself. It is this law of reaction under which homœopathy works, by its similars stimulating the additional resistance necessary to aid in nature's cure.

If you go out into excessive cold, and the power of resistance is equal to the demand, you turn red; if not, and this power is overwhelmed, you turn white. And the same difference is markedly observable among those who take sea-baths. By the law of reaction they vary in color from that of a boiled lobster to the livid hue of death, graduated and shaded off by the loss of the power of resistance. All cures are sought by homœopathy under this law, and depend for their success upon this power of resistance, and it is of vital importance that this power be not diminished, for without it there can be no cure. Outside of medicine this law of reaction in the system is recognized as an accepted fact. It is the law of cure, and the study of this law is a science, and that science is homœopathy.

The reason why scarlet fever, measles, chicken-pox, and small-pox do not, as a general rule, recur in the system is that, at the first attack, the system has reacted so strongly against these diseases as to be proof against a second attack. The reaction has so strengthened the system to resist the particular form of morbific influence that it will not readily yield to it again.

"Homœopathy is another form of quackery," says a writer in the June number of "The Popular Science Monthly." It might be objected to his method of treating the subject that no *a priori* argument can suffice in the forum of reason where practical tests and material results may be had, by any one so in love with the truth as to seek it, by going frankly to eminent homœopathic physicians and obtaining permission to study their treatment in a given number of cases, and, with a mind disabused of prejudice, carefully examining and noting each case and giving the results of such observations. There would then, at least, be some facts which would give currency to the alloy of mere argument.

There is certainly no more reason, viewed from a logical standpoint, why the inducing of symptoms or sufferings different from those produced by disease should prove more efficacious in cure than a remedy which produces similar symptoms. It may be so; but the mere assertion does not establish it. The question is one of fact; it does not belong to the domain of reason. However absurd the theory of one school may appear to a disciple of the other, the question remains, Which system cures?

It is asserted that infinitesimal doses, a decillionth part of a grain, can not cure. This statement is based upon the assumption that a dozen, or twenty, or more grains, given by the allopathic school in single or quickly repeated doses, are necessary to effect a cure, and that so given they do cure, which is to assert that allopathy is the only true standard and measure of cure, and that any material deviation therefrom is error. But, if the premise be denied, the conclusion fails.

Of the uncertainty of cure by allopathic remedies, let one of the most eminent of that school speak—that man of attainments and ability, Sir John Forbes. In his work entitled "Nature and Art in Disease," a solemn legacy to his younger brethren, he says:

"And yet what is the character of the results obtained under this system" (homœopathic) "of imaginary medication in the cure of diseases? When fairly weighed do not these results exhibit, if not quite as large a proportion of cures as ordinary medicine, still so large a proportion as to demonstrate at once the feebleness of what we regard as the best form of art and the immense strength of Nature in the same office. . . .

"The favorable results obtained by the homœopaths—or, to speak more accurately, the wonderful powers possessed by the natural restorative agencies of the living body—demonstrated under their imaginary treatment, have led to several other practical results of value to the practitioners of ordinary medicine. Besides leading their minds to the most important of all medical studies, that of the natural history of diseases, it has tended directly to improve their practice by augmenting their confidence in Nature's powers, and proportionately diminishing their belief in the universal necessity of art, thus checking that unnecessary interference with the natural processes by the employment of heroic means, always so prevalent and so injurious. It has been the means of lessening in a considerable degree the monstrous poly-pharmacy which has always been the disgrace of our art, by at once diminishing the frequency of administration of drugs and lessening their dose. . . .

"In a word, almost every drug in our overflowing materia medica, whether inert or active, has been on one ground or another copiously prescribed in every variety of disease under the supposed sanction of this pseudo-specific on empirical indication. Nor let it be supposed that this empirical practice is one of the past day only. It is at this very time in as great vogue as ever, although its employment may be often veiled under the technicalities of newer science.

"Nor is it confined to the ignorant or inexperienced among us, but adopted and followed by men of the greatest abilities and greatest eminence in the profession. . . .

"As in religion and politics, and in those departments of knowledge which are not of a positive or demonstrable kind, early and long-continued education, comprising not merely direct instruction, properly so called, but the influence of habitual example, deference to seniority and superiority, unconscious imitation, etc., induce conventional belief of the strongest kind—strong as demonstrated truth itself—and create a sort of wizard circle of power, beyond which the mind of the disciple, however bold, scarcely ever dares to wander. So in medicine, the great majority of practitioners retain the same doctrines and pursue the same practice which they learned in the schools, or, if changing both doctrine and practice, as time and fashion dictate, hold fast, at least, the great fundamental doctrine impressed upon the very core of their professional hearts—viz., that the interference of Art is essential in all cases, and therefore never to be foregone. It need not, therefore, surprise us that it is only a very small minority of medical practitioners who, in ordinary circumstances, can see in disease the true workings of Nature through the artificial veil which conventionalism and professional superstition have thrown over them. . . .

"The conviction of the great autocracy of Nature, in the cure of diseases derived from this source, is much more widely spread among the senior members of the profession than is at all believed by the great body of practitioners. . . . The number of cases that recover and would have died had Art not interfered is extremely small."

These trenchant words from Sir John Forbes carry great weight as a commanding critic in his own profession. Had his strictures upon his brethren and their practices come from an alien pen, they would undoubtedly have been attributed by the allopathic school to malevolence and ignorance; and, doubtless, Sir John Forbes will not escape the same fate, because, if his statements are true, those of whom they are spoken are incapable of perceiving or admitting their truth.

But, conceding the allopathic to be a correct or a possible system of cure, it by no means follows that because it requires large doses to create different symptoms or sufferings, it likewise requires doses of equal quantity to create *similar* symptoms to those to which the system is already so greatly predisposed.

The atomic dose will, however, bear a much closer and more severe test than has been applied to it. It is an approved and well-known fact that a person of iron will will battle long and successfully with a disease which baffles the aid of the most skillful physician, and it is said that his will sustains him. By that is not meant that he leans upon his will as upon a staff, nor that the immaterial, the will, comes in actual contact with the material, the disease; but that the will, acting through the brain, rouses up in the system material resistance to the disease, and effects a cure or prolongs the fight. How much brain would one have to eat in order to obtain a decillionth part of a grain of the will-power which operated in the system in effecting a cure or battling with the disease? The will operating through the brain moves one joint of the little finger, then two, then three, and so on until it moves by one operation of the will the whole fourteen joints of the five fingers, which act in unison at one motion. Yet it is clear that each additional joint moved resulted from the impression made upon a larger area of the nerve-centers in the brain. Assuming for the sake of argument that the correct method of cure is to arouse in the system a direct reaction against disease, and that this can only be accomplished through the brain, it follows that the remedy, which in form is best adapted to act upon the brain, is the best so far as mere form is concerned; and if the immaterial, the will, can produce such positive physical results, the quantity of the medicine operating upon the brain is not required by any law of physics (or physiology) to be many times greater than the nerve-cell, which is the body to be operated upon; especially must this be true when the object sought is not to overwhelm the nerve-center, but simply to stimulate it to increased action.

Professor Calderwood, in his "Relations of Mind and Brain," says of the nerve-cells in the brain: "These are so numerous as to baffle calculation. From the number seen within a small section under the microscope, it is reckoned that there must be many thousands of them in the human brain." Of the nerve-fibers he says: "In the brain itself they are sometimes as minute as a twelve-thousandth part of an inch," and that the smallest of the nerve-fibers in the eye are from $\frac{1}{30000}$ to $\frac{1}{60000}$ part of an inch in diameter. As an adaptation of means to end, a decillionth part of a grain, broken up into many still more minute particles, does not appear to be so much out of proportion to the nerve-cell or to the ducts, the nerve-fibers, as the two, four, six, or more grains given by the allopaths.

The stench contained in a few drops distilled by a skunk attains a potential existence in the air for not less than five hundred feet in every direction. Taking one thousand feet cubed as a minimum, we have one billion cubic feet of air saturated with the smell. Not only is this space filled once, but it is kept filled for an hour, radiating out indefinitely into space; from which it is clear, according to our critic, that a passer-by, an hour afterward, deceives himself by a supposititious shock to the sense of smell caused by the decillionth part of the drop of skunk-odor. But the involuntary clapping of the hand to the nose affords conclusive proof that both the sensor and motor nerves have been sensibly affected.

That in a chemical laboratory there is no appliance so sensitive as a diseased nerve, does not argue the inefficacy of the atomic dose, but proves the want of adaptation of the chemical apparatus to deal with the subject.

Hahnemann's method of trituration is urged as an argument against his principles, without showing that it has anything to do with the principles, or that it fails to accomplish the object sought. The work is now done with great exactness by machinery.

It is said that since the discovery of the *Sarcoptis hominis*, or itch-insect, the dogma about psora being such a powerful factor in the causation of diseases has fallen to the ground; that is to say, that those who supported this theory have been, by this discovery, forced to abandon it. Why? Evidently because the theory is inconsistent with the itch-insect. But who proves it? Is the disease the cause of the insect, or the insect the cause of the disease? Do maggots breed carrion, or carrion maggots? Was Hamlet trying to shift the responsibility of Polonius's death from himself to the worms?

"Now, Hamlet, where's Polonius?"

"At supper."

"At supper! Where?"

"Not where he eats, but where he is eaten. A certain convocation of politic worms are e'en at him."

That is, the worms killed Polonius.

But it is clear that Hamlet was not so mad as that, for he said, "For if the sun breed maggots in a dead dog, being a god-kissing carrion—"

So will psora breed the *Sarcoptis hominis*, but so will not the insect breed the itch. Being but the effect, it can not produce the cause. It is not its own *causa causans.*

Homœopathy has suffered, and is likely to suffer, more from its friends than from its enemies.

Persons who adopt it as an easy means of gaining a livelihood are apt to fail, and fall back upon the allopathic school, with its nosology and procrustean prescriptions. Few are those in any calling who have either the frankness to confess or ability to perceive the cause of failure to be from within. The convenience of a name for every disease is apparent. It relieves from further investigation. How little Dr. Shepherd knows of the laws of homœopathy may be demonstrated by a single sentence. He says: "Hahnemann paid no attention to pathology or cause of disease, but only sought for symptoms. For instance, in a case of dropsy, the cause, whether it be from the heart, the kidneys, or the liver, is not inquired into, but *the symptom dropsy is treated.*"

It is clear that the writer here uses the term "cause of disease" as synonymous with the part affected, which is to confound cause and effect, and he substitutes his own nosology "dropsy" for the group of symptoms which indicate, not dropsy, but the remedy to be selected. The fact that the heart or kidneys or the liver is affected does not indicate or prove that the one affected is the cause of disease. It proves that the disease has affected that part, and it follows by an inexorable law that the part affected can only be cured by removing the cause. It is this inversion of cause and effect, of disease and its point of attack or expression, this ignorance of Nature's laws, which induces the allopath to attempt to cut out the core of what he calls cancer; thus trimming the branches of this mighty disease, to strengthen it at the roots, seated deep down in the system. It is like cutting down a locust, and producing a forest from the roots. How can a school, which has been a thousand years dissecting dead bodies to discover the vital principle, hope to free itself from its dogmas? As well might it be expected to discover the electric fluid by dissecting a yard of telegraph-wire. Professor Calderwood, who is not a homœopathist, demonstrates, as a scientist, from the discoveries of the foremost physiologists and psychologists, that, by tracing up all of the group of symptoms along the nerve-fibers, we will reach a common nerve-center in the brain, differing in area and location with differing groups of symptoms. This nerve-center is operated upon by certain sensor nerves. The whole object of the homœopathic physician, who is true to the law, is to trace these symptoms to a common nerve-center, and then to select a remedy which, acting upon that nerve-center, will, on the line by which Nature cures, stimulate a reaction, and thus restore the equilibrium, which is perfect health.

The law of Nature's cure is, by rousing up reaction against disease, to restore the disturbed forces to their exact counterpoise, where action and reaction are equal. The allopathic method of creating a new disease to cure the old one is a violation of this law, and at the very outset the regular school must begin by an apology or an excuse, either that Nature has denied to men the means of executing her laws, or that man is ignorant of the means she has placed at his disposal.

As an abstract question, preference must be given to that method of cure which creates the least disturbance in the system, and, as a consequence, leaves it less liable to relapse or a second attack; which does not by antagonizing the vital forces reduce or destroy its economies; which does not work by rule of three; as the remedy is to the disease, so is the constitution to the condition of the patient when the disease shall have left it. Convalescence in homœopathy commences when the correct remedy begins to act. In allopathy, when the remedy and disease have left the patient prostrate, then Nature takes the matter in hand. It is a common error with the ignorant traducers of homœopathy that the higher the potencies or its remedies the weaker they become, as one weakens wine by adding water. It is sufficient answer to quote the following high authority, who discloses the true purpose and effect:

"If it be conceded that the vital principle is identical with electricity, the action of dynamized medicaments becomes easy of comprehension; for in these preparations we have material substances subdivided to a degree that enables them to penetrate the most delicate tissues of the body."—(Dr. Currie's preface to Jahr's "Homœopathic Manual.")

The writer's assertion, that "homœopathy, being a system utterly void of any scientific foundation, is now dying a natural death," receives, to say the least, doubtful support from the animated debate which has been progressing so vigorously in the New York County Medical Society of the regular school in reference to consultation with homœopaths, where the exclusionists accused the more liberal brothers of having an itching palm for the fat fees which now find their way, without chance of tax, to the pockets of the homœopathic physicians, while the argument by the liberal members is that as now homœopathy has progressed and its disciples have a thorough medical education, there is no longer any reason why they should be treated as quacks and impostors. So far as noted, the alleged moribund condition of homœopathy had escaped their observation.

What shall be said of the pretensions to be enrolled with the sciences of that school which has progressed from one stage of universal disease or cause and remedy to another — typhoid, malaria, miasm germ, bleeding, calomel, morphine, quinine — by discarding nearly all that its pioneers held most dear; which, before it can build, must tear down; which retreats from the necessary labor of that scientific investigation which by great diligence and skill eliminates every remedy but one as useless or hurtful, to take refuge in a nauseous mixture of several powerful drugs, administered upon the hit or miss blunderbuss principle — those drugs which are neither allopathic nor homœopathic to the disease, doing more potent injury than the one (which by hap-hazard has some relation) can do good, as Sir John Forbes says, "the monstrous poly-pharmacy which has always been the disgrace of our" (the allopathic) "art"?

It may well be doubted whether homœopathy will ever have enrolled under its banners the same number of practitioners as the regular school. The nearer we approach to an exact science, the fewer are its votaries. The conditions admit fewer. In it there are no formulated diseases nor formulas for prescriptions. It is differentiation as opposed to classification or generalization. The effect, expression, or impression of disease, is not mistaken for disease as a cause. Subject one hundred persons of both sexes and various ages to a cold rain and then to a burning sun, and you will have as many different states as persons. The disturbance of the vital force has found expression in a hundred different forms. It is in the province of the homœopathic physician to locate the center of disturbance, and then to select as the remedy, by a process of elision from the many similars in the materia medica, the one which most nearly coincides with the expression of the disease or symptoms. When this process sometimes involves the most experienced and skillful physician in a profound study of one, two, and three hours and of re-examination as the expression changes, requiring due weight to be given to each symptom, both relatively and positively, and then to assume the grave responsibility of administering a single remedy and awaiting the result, it will be readily seen that those who are faithful to the law, and able to administer it, will be few.

By operation of the will a strong man liberates from a nerve-center of his brain nerve-energy which, acting along the motor nerves, liberates in its turn sufficient muscular energy to fell an ox. Here the immaterial, the will, has produced a most powerful material result. Suppose for a moment that the nerve-energy had been misdirected, as in case of shock from mental causes, and had all been expended within the man, who would answer for the result?

In the heroic struggle which Nature, unaided, makes against disease, the assistance from Art necessary to speed the cure may in a great majority of cases be set down in decimals, as follows:

Nature	·999
Art	·001

and it will be pretty safe to say that, whenever the proportion is against Nature, there will be no cure.

It is the $\frac{1}{1000}$ which Art is called upon to throw into the scales and make them equal. If she adds more, she destroys the balance.

The atomic dose is adjusted to restore the balance. It is the infinitesimal fraction Nature needs to make the unit health.

If you accept the germ-theory of disease, and attribute to the atomic germs, floating impalpable in the air, or carried long distances through the mails on highly calendered writing-paper, from mere contact with the hands of diseased persons, the power of communicating disease and completely overwhelming the vital power, causing death, you can not logically deny to the atomic dose all aid to the vital power in resisting and defeating the attack of the atomic germ of disease simply because the dose is atomic. Nature, unaided, in a vast number of cases, successfully resists those diseases which are attributable, by those who maintain the germ-theory in disease, to atomic germs. The number of disease-germs does not matter, as is evidenced by the communication of disease by letter where the number must necessarily be limited. The atomic dose is but a stimulus to Nature. Nature cures, aided or unaided. The atomic dose but excites in a greater degree those powers of reaction and resistance of Nature already set in motion by disease—which is a disturbing cause. Nature always seeks to restore the equilibrium of her forces.

THE LIVER-FLUKE OF SHEEP.

By BYRON D. HALSTED, Sc. D.

THE object of this paper is to briefly summarize the present knowledge of the liver-fluke, causing the much-dreaded and fatal "rot" in sheep. Professor A. P. Thomas, of Balliol College, Oxford, has completed his long and extended researches on this parasite, which have been carried on under the direction of the Royal Agricultural Society of England. Professor Thomas's concluding report appeared in the last issue of the "Royal Agricultural Journal," from which the leading facts here given are drawn and the engravings borrowed.

The liver-fluke, shown twice the natural size in Fig. 1, is a sucking-worm related to the common leech, and known to zoölogists as *Fasciola hepatica.* It has the shape of a privet-leaf, is pale brown or flesh-colored, and from an inch to an inch and a third in length. There is a short projection at one end, and at its tip, *y*, is a sucking-mouth by which the fluke can attach itself to the surface of the bile-ducts of the sheep. A second sucker, *y'*, is situated at the place where the head joins the body. These flukes are found in abundance in the livers of sheep and other animals infested with the "rot," and produce vast numbers of eggs. Each of these eggs under proper conditions gives rise to an animal "which is never like its parent, never does become like it, and never lives where its parent lives." It will be seen that in the liver-fluke we have an example of what is known among naturalists as an alternation of generations.

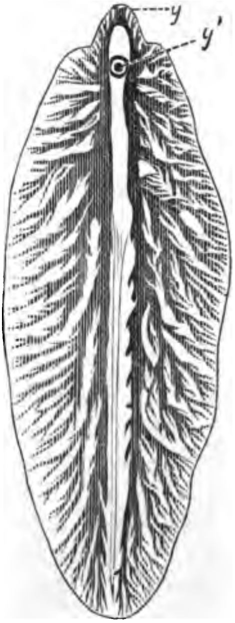

Fig. 1.

The eggs, one of which is shown in Fig. 2 very highly magnified, are about $\frac{1}{200}$ of an inch in length, but may be made visible to the naked eye by shaking some of the dark-brown contents of an infested bile-duct in a glass of water and holding the vessel up to the light. The line marking off the lid of the egg may be seen near the right end, and a little to the left is the embryo in its early state of development. It is surrounded by large granular masses, which serve as food. Only three of these masses, at the left hand, have been fully drawn. In one case Professor Thomas found seven million eggs in the gall-bladder of a single sheep, while the liver contained about two hundred flukes. The number of eggs produced by a single fluke may be safely estimated as half a million. No further changes take place in the egg

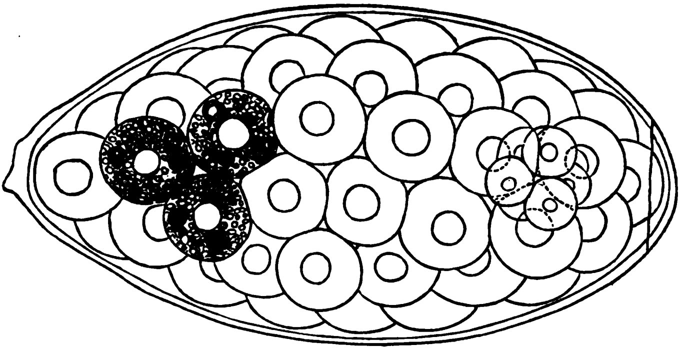

FIG. 2.

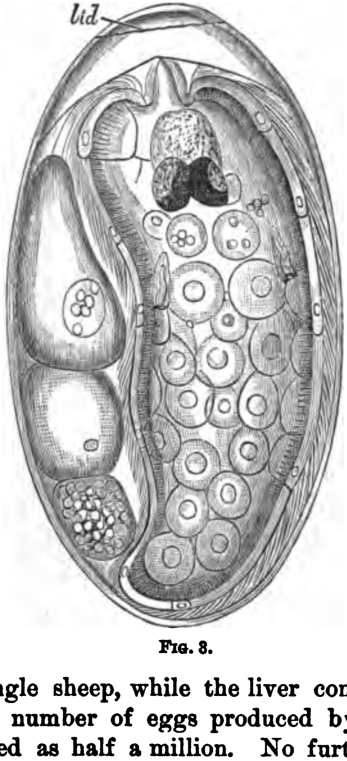

FIG. 3.

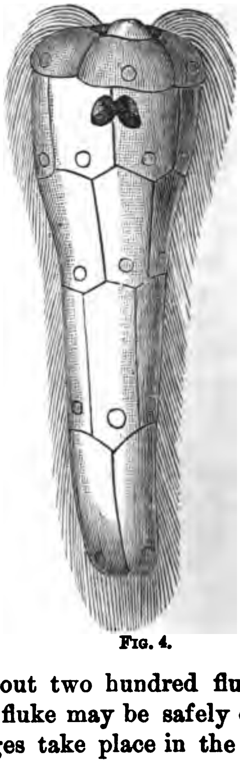

FIG. 4.

while it remains within the infested sheep. The eggs are, however, naturally washed away by the bile into the intestines, and finally pass from the sheep and are distributed with the droppings. If the eggs fall upon wet land, further changes take place during warm weather, and an embryo is formed. Fig. 3 shows a fluke-egg with the embryo fully formed within the shell. The body of the embryo is covered with cilia, by the motion of which the young trematode is propelled through the water. Both of the engravings (Figs. 3 and 4) are highly magnified. In swimming, the broader end is directed forward, and in its center is a projection, used as a boring-tool. The embryo has very simple eye-spots, which render it sensitive to light, and aid it in finding its future home. When the swimming embryo comes in contact with any object, it feels about, and, if not suited to its wants, starts off again. If the object met with is the snail (*Limnæus truncatulus*), shown in Fig. 5, it at once bores into it. In boring through the shell of the snail, the peg-like projection is extended, and the embryo spins around rapidly by means of the cilia. The natural place for the further growth of the embryo is in or near the lung of the snail, and when once lodged there its eye-spots and cilia disappear, and the body becomes oval in shape. Figure 6 shows the embryo while the changes are taking place. When the changes are completed the animal is called a *sporocyst*, meaning a sac of germs. The sporocysts live at the expense of the snail, and will, in July weather, reach their full growth, $\frac{1}{40}$ of an inch, in a fortnight. Fig. 7 shows a full-grown sporocyst, or first generation of the liver-fluke. It contains a number of germs, the lower one of which is ready to hatch out. This is the second generation, and is named *redia*, after Redi, the celebrated anatomist. The young redia, when ready, breaks through the wall of the parent, and the wound thus formed closes up, and the re-

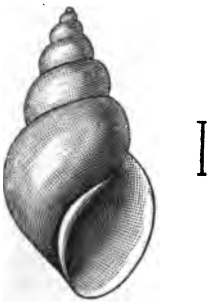
FIG. 5.

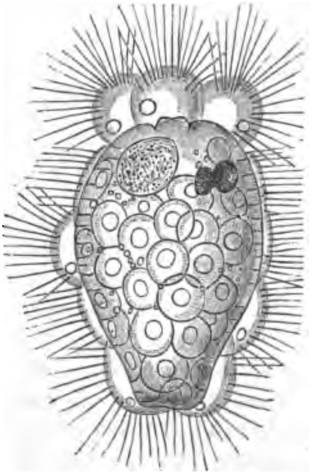
FIG. 6.

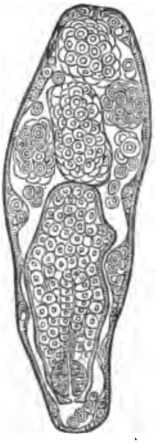
FIG. 7.

maining germ rediæ continue to grow. The sporocysts also multiply by simple division, thus causing still greater increase in the number of parasites in the snail. A young redia is shown in Fig. 8, with the contents forming into the third generation of the liver-fluke. A full-grown redia is seen in Fig. 9, much magnified. Some of the germs of the *cercaria*, as they are termed, may be seen within the redia. Each of these germs develops into a tadpole-like animal, with a slender tail. A redia may produce a score of the cercariæ, which escape from the parent through a special opening and then wriggle their way out of the snail. The free-swimming life of the "tadpole" does not last long, and after coming to rest it draws its body into a small sphere, and exudes a gummy substance, which protects it from injury. These encysted cercariæ are destined to find entrance to the liver of the sheep and then develop into the full-grown fluke. Fig. 10 shows a free cercaria as seen swimming in water, and in Fig. 11 is seen a portion of grass upon which three cysts are fastened. The cysts remain attached to the herbage of the pasture, and are swallowed by the sheep in feeding upon the ground. If the cysts are not picked up by the sheep within a few weeks, the young flukes which they contain will perish. It has been determined that two hundred or more cercariæ may descend from a single fluke-egg, and, if the rediæ give rise to a generation of daughter-rediæ, a single egg may produce more than a thousand cercariæ. "Not only does the race of the liver-fluke multiply and increase abundantly in the sheep by producing myriads of eggs, but there is a further and great increase of the forms within the snail. If only the greatest degree of ordinary increase were reached, a single fluke might give rise to more than a hundred million descendants in the next generation of liver-flukes proper inhabiting the sheep. But, fortunately for farmers, the chances are enormously against any such disastrous increase."

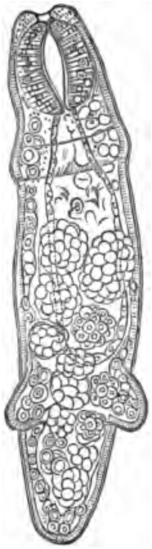

Fig. 8.

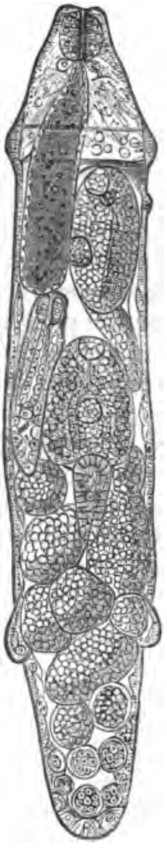

Fig. 9.

Professor Thomas has determined that at least six weeks elapse, from the time the encysted cercaria is swallowed by the sheep, before the fluke is fully grown and begins to lay eggs. The flukes do not always pass from the sheep in summer-time, as was once thought by leading veterinarians. There is no time of year when sheep-livers containing flukes can not be obtained. Cases are known where the flukes have been known to live for more than a year.

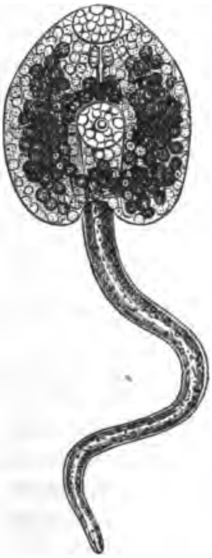

FIG. 10.

FIG. 11.

The summary of the life-history of the liver-fluke is given as follows: "The adult fluke in the liver of the sheep produces enormous numbers of eggs, which are distributed with the droppings of the sheep. If these eggs have moisture and a suitable degree of warmth, they continue to live, and in each is formed an *embryo.* The embryo leaves the egg and swims in search of the particular snail (*Limnæus truncatulus*) within which its future life and growth take place. The embryo bores into the snail, and then grows into the form which is called a *sporocyst.* The sporocyst gives rise to the second generation. This generation is known as the *redia.* The rediæ in turn produce the third generation, which has the form of a tadpole, and is called *cercaria.* The cercariæ quit the snail and inclose themselves in envelopes or cysts, which are attached to the grass. When the grass to which the cysts adhere is eaten by sheep or other suitable hosts, the young liver-fluke comes out of the cyst and takes up its abode in the liver of its host, and the fatal circle is thus completed."

The fluke-disease alternates between a kind of snail and the sheep. One sheep can not contract the "rot" directly from another member of the flock, and one snail can not take it from its neighbor. The sheep drop the eggs, and hatching, the embryos, find the snails, and the snails after nursing the young flukes through three generations distribute the tadpole cercariæ, which convey the infection back to the sheep, and it there inhabits the liver and causes the disease.

THE PREVENTION OF THE ROT.—Now that the life-history of the fluke is known, it is not difficult to comprehend the conditions necessary for its existence. There must be: (1) Fluke-eggs on the ground; (2) wet ground or water during warm weather—(3) the snail *Limnæus truncatulus* (?); and (4) sheep allowed to feed upon the infested ground.

Under the first condition it may be said that wherever fluked sheep are kept we shall have fluke-eggs. In some districts flukes are always to be found, and where the conditions are the most favorable a sudden outbreak may be expected. The disease sometimes appears in quarters where it was previously unknown, and may have been introduced in manure containing fluke-eggs, or adhering to the feet of cattle, dogs, or men. The eggs and young flukes (embryos) may be conveyed by running streams, floods, etc. Other animals than sheep are infested with the parasite, and rabbits and hares may be the means of introducing the plague. The production of the fluke-eggs may be prevented by killing the sheep so soon as they are found suffering from the "rot." If there is a suspicion that a flock is attacked, one of the members exhibiting the strongest signs may be killed and its liver examined. If rotted sheep are kept, they should be on dry ground, where the fluke-eggs can not fall on wet land, or be swept into brooks by the descending rains. The manure of infested sheep should not be placed on wet land, and the livers of rotted sheep ought to be destroyed or deeply buried.

The remedy for the second condition is a simple one, but not always easy of application. Wet land should be thoroughly drained, and, besides preventing the rot, it will greatly improve the pasturage. When draining can not be done, lime or salt may be scattered over the surface. These substances will destroy the embryos, the more developed encysted form of the fluke, and the snails which serve as hosts. The salt or lime should be applied in early summer, when the young flukes are present in the greatest numbers.

There seems to be only one snail in England which is host to the young flukes, and the accounts of Professor Thomas in exposing other species of *Limnæus* to the embryos of the fluke are most interesting. The *Limnæus truncatulus* (Fig. 5) is said not to exist in the United States, though several other kinds of snails belonging to the same large genus are found here. It is probable that with us some other species than *Limnæus truncatulus* serves as the host of the intermediate forms of our liver-flukes. Draining the wet land will reduce the number of snails; and dressings of lime or salt, as above mentioned, also destroy them. The lime should be scattered especially on or near marshy places and along ditches. If a pasture has been flooded, it is well to use the lime to destroy snails which may have been brought down from infested areas.

If there is suspicion that a lowland is likely to give the "rot" to sheep, the best plan is to not allow them to feed upon it. In seasons of excessive moisture it may be impossible to keep the flocks on dry pastures. Salt, as a preventive, may be used in a second way. It acts injuriously upon the germs when fed to the sheep, and it also improves the general health of the animal. In addition to the salt, use dry feed as much as possible. The sheep should not be allowed to graze too closely, for the snails, as a rule, keep near the ground.

If all farmers would unite in carrying out the above preventive measures given by Professor Thomas, the losses from a fatal disease would be greatly reduced. Rabbits and hares are an obstacle to the total extermination of the "rot" in sheep.

The literature of the liver-rot in sheep is specially interesting in the light of our present knowledge. Jennings, in his work on "The Horse and other Live-Stock" (1866), says: "The malady is unquestionably inflammation of the liver. These fluke-worms undoubtedly aggravate the disease and perpetuate a state of irritability and disorganization, which must necessarily undermine the strength of any animal. . . . The sheep, having a little recovered from the disease, should still continue on the best and driest pasture on the farm, and should always have salt within their reach." Youatt, in his work on sheep, in 1848—back of which date it is not worth while to go—wrote at length upon the "rot." He located the disease in the liver, and states that it has existed from the earliest period of agricultural history. His description of a diseased sheep was full and quite accurate, but the cause was unknown to him. He says, without qualification, that it is inflammation of the liver. The full-grown fluke is too large an object to escape notice in the examination of an infested liver, and therefore was known to Youatt and the veterinarians of his day, but was considered the consequence instead of the cause of the "rot." They believed that the "rot" was connected in some way with the soil, it being confined to wet seasons and to sheep which fed on marshy lands. "It has reference to the evaporation of water, and to the presence and decomposition of moist vegetable matter." In other words, the gases arising from decomposing organic substances cause the "rot." Randall, in his "Sheep Husbandry," states that this view at that date (1860) was universally received by scientific veterinarians. H. Clok, V. S., in his "Diseases of Sheep" (1869), says the "rot" is analogous to "fluke," and is produced by many causes, among which "grazing on marshy or sour meadows" is a leading one. In speaking of the fluke, he says, "The worms are found spontaneously, like all other worms of the viscera, and the opinion that they are introduced into the body with the food, drink, etc., must be considered erroneous."

With the first symptoms of the liver-fluke in sheep there is a tendency to fatten, and animals intended for the shambles have been purposely rotted in order to increase their fattening properties. A celebrated stock-man in England used to overflow his pastures, and, after the water was run off, turn on his sheep which he was preparing for the market. These animals became infested, accumulated flesh rapidly, and by this manœuvre a gain of some weeks was obtained. The practice is certainly questionable, if not positively vicious.

The writer claims no originality in the present paper, and only acts the part—and that imperfectly—of a middle-man in science.

CYCLONES AND TORNADOES.

By GEORGE CLINTON SMITH.

CYCLONES.

TOWARD the western portion of the United States, along the twenty-fifth parallel of longitude, lies a vast tract of sandy, arid country, known to the earlier geographers as "The Great American Desert." It is true, the limits of this great area have become circumscribed by the onward march of civilization, but the sandy waste is still there, and must ever remain. Still farther westward, the Rocky Mountains rear their lofty, snow-crowned heads in one continuous chain, three thousand miles in length. Rich in mineral wealth, the delight of tourists, and the home of a prosperous people, these mountains have a different and equally valuable office to perform in the exercise of an important influence upon the climate of our continent. Were they to be removed, the entire territory west of the Mississippi River would soon become an arid, lifeless desert.

All storms, of any magnitude, that visit the United States, except the tropical hurricanes which sometimes touch the southern coasts, have a common origin in or near the Rocky Mountains. Here the first barometric depression is felt, preceded by a rising temperature, caused by the warm winds moving northward over the sun-heated sands of Arizona, New Mexico, and Western Texas. These warm, rarefied currents of air are met by cooler currents passing over the snow-clad peaks of the north; a cyclonic storm is formed, usually small at first, which begins its journey eastward, gradually developing in energy and area as it goes. After leaving the mountain-ranges, there is but little precipitation for the first few hundred miles; as it advances, it usually widens from north to south, but the line of travel of the storm-center can be readily predicted by the Signal-Service observers, and its location at any time fixed by the lowest reported reading of the barometer.

During the journey of the storm eastward or southeastward, the wind in advance of it will be easterly, blowing off an area of high barometer into the low; and the barometer will continue to fall. Toward the north of the storm, the wind will be north; and to the south of it the wind will blow from the south, frequently causing what are known on the Western plains as "sand-storms"; while, if the storm occurs during the winter season, the wind and snow in the northern portion is called a "blizzard." In the rear of the storm the wind will be westerly, shifting to northwest, frequently blowing a gale; the barometer will rise and the temperature will fall, sometimes rapidly, and clearing weather will follow.

Thus it will be observed that the true axis is the "storm-center," and that the storm revolves on this axis as it moves forward in an easterly, northeasterly, or southeasterly direction. This is the true cyclone. It may be only a few hundred miles in diameter, or its influence may be felt from British America to the Gulf of Mexico. It may be accompanied by what are known as local showers or storms; or the rains may be general, and of several days' duration. The greatest precipitation is frequently in advance of the storm-center, and may be either rain or snow, depending upon the season of the year and the temperature. During the spring and summer months the area of low pressure is usually accompanied by precipitation in the form of local showers, or thunder-storms, of more or less severity, in which case the strongest air-currents move with the local storm-cloud, and are known as simply high winds, sometimes approaching the severity of a hurricane, but seldom extending over any considerable area of territory.

The true cyclone usually travels from the Rocky Mountains to the Atlantic coast, in nearly a straight line. Sometimes the distance is traversed in four days and nights, exceeding the speed of a railway express-train; but frequently the progress is slow, and the time required much longer, depending largely upon the atmospheric conditions met with in the vicinity of the Great Lakes.

Frequently, while the wind may be blowing from the southeast or northeast, or between these points, the storm is approaching from an opposite direction, and pushes out its cloudy streamers, or "feelers," hundreds of miles in advance. There is, then, no such thing as a "northeast storm," as far as the interior of this continent is concerned.

TORNADOES.

The origin and movement of continental cyclones being understood, we naturally turn, next, to the investigation of tornadoes. These seem to occur most frequently in the Western States, and are usually confined to the territory between latitude 35° and 45° north, and longitude 10° and 25° west. They are purely local in effect, although their cause may be remote; always depend upon and frequently accompany the meteorological conditions developed during the progress of the cyclone proper across the country. They may occur near, or in advance of, the cyclonic storm-center; or they may appear near the outer edge of the general disturbance, hundreds of miles away. They usually develop within the area of highest temperature, and are often preceded by a brassy sky, and hot, gusty winds, sometimes followed by a sultry atmosphere and an ominous calm. They occur most frequently near the close of the day, their general direction being from southwest to northeast. They vary much in size and force, but all have the same general characteristics in regard to appearance and action; being a funnel-shaped cloud, heavily charged with electricity, that goes bounding and whirling along in close proximity to the earth's surface, dealing death and destruction wherever it touches. The generally accepted belief is, that tornado-clouds are formed suddenly, by the meeting of warm and cold currents of air; or, by the union of a positive with a negative cloud, a partial vacuum being formed, constitutes the axis around which the cloud begins to whirl, gathering strength and increased velocity as it goes.

As the tornado now sweeps onward in its course, it rises and falls with a series of bounds, and, with a swaying motion, describes a zigzag course, now forming a chain of loops, and again shooting off on an obtuse angle, varying in the speed of its forward motion, which may be anywhere from ten to thirty miles an hour. At the same time it is rapidly whirling on its axis in the opposite direction from a screw, or the hands of a clock, the air revolving around the vortex necessarily attaining a speed of several hundred miles an hour. First widening, then contracting, now bounding above the tree-tops, and again descending to sweep the earth bare of every object within its reach, the aërial monster surges onward. The largest forest-trees, mere playthings in its grasp, are plucked up by the roots, or snapped off like pipe-stems; substantial buildings are first crushed like egg-shells, then caught up in the vortex and the *débris* carried sometimes for miles, before it is again thrown off by centrifugal force, and falls by gravitation anywhere, everywhere, as soon as released from the monster's grasp.

It is difficult accurately to describe the tornado's appearance and work, even for those who have been eye-witnesses, or who have personally passed through the horrors its coming brings. While accounts differ as to its appearance and behavior, as witnessed from different points of observation and under different circumstances, all substantially agree that it is cone-shaped, its motion rotary, that its apex resembles fire and smoke, and that vivid lightning and heavy rain-fall usually accompany it. In rare instances, electricity, in the form of St. Elmo's fire, will precede the vortex, and a white, steamy cloud will follow. It will be observed that the form of the tornado-cloud is nicely illustrated by the "proof-plane" used in teaching natural philosophy. The small end of the plane is most heavily charged with electricity, and, the nearer it approaches to a perfect point, the greater will be the accumulation: a high tension is caused, and the electricity must escape by some conductor. So, in the tornado-cloud, the smaller the point or stem, the greater the force exerted when it meets the earth.

The bounding or swaying motion of the tornado can be illustrated by the experiment of the "electrical puppets": the cloud above forming the upper plate, and the earth beneath the lower one. All light objects between are drawn up, then thrown down—being first attracted, then repelled.

While the tornado, on its course, possesses four distinct motions—as previously stated—there seems little doubt that the central force, or the one exerting the greatest power, is purely electrical, although the outer surface of the vortex be composed of wind moving at a rate of speed that can scarcely be comprehended.

So many readers are already familiar with statements frequently made regarding the tornado's strange freaks, that a few illustrations only will be given.

Mr. C—— states that, during the tornado which visited Sangamon County, Illinois, on May 18th of the present year, while himself and family had taken refuge in the cellar, a sulphurous smell prevailed, a ball of fire burst above them, and they were severely burned about the face and neck, but otherwise uninjured, although the house was torn from over their heads.

The family of Mr. T——, who had also sought shelter in a cellar from the same storm, were covered with a gummy substance, which would not wash off! This substance might have been formed from the sap of trees and juice of leaves, combined with the moist, heated atmosphere. In passing over the track of the tornado, the writer observed two large elm-trees torn out by the roots; one had fallen to the east, the other to the west, and the tops of both were firmly interlocked. A short distance from these, a white-oak tree, thirty inches in diameter, was broken off and lay upon the ground, the top toward the west; on top of this lay another large tree, which had stood in a northwest direction from the first. The rotary motion of the destructive force was here clearly proved. A thrifty young maple-tree, twelve inches in diameter, stood apart from other trees, near the edge of the storm's track. About six feet from the ground the bark was peeled entirely off for a distance of two feet. No broken limb, or other missile, lay near the tree, and its top was uninjured! Could this effect be produced by wind? Was it not, more likely, caused by concussion?

In the same tornado a whole orchard was swept away; the large trees carried one fourth of a mile, stripped of their bark and smaller limbs, and completely plastered with mud. A wagon-tire was torn from the wheel, straightened out, and driven into the side of a building. A flock of geese were plucked of their feathers, which were deposited in a hedge-fence, giving it a complete coating.

Credible persons testify to having seen a horse carried over the roof of a barn, and again let down, without receiving serious injury. A child's necklace, with locket attached, was picked up in the village of A——, having been carried by the storm from W——, eight miles distant! Mr. and Mrs. T——, living in L——, were both killed, and their house destroyed by the tornado. A vest belonging to Mr. T——, containing valuable papers and a sum of money, was found in the town of P——, twenty miles away, and restored to the relatives of the deceased owner!

Wagons, agricultural implements, and household furniture, will be carried a long distance and broken into fragments by the tornado, while delicate mirrors and sets of glass-ware may be spared. The giants of the forest will be torn to splinters, while the modest flowers beneath them are left blooming as sweetly as if nothing had occurred!

The belief has obtained to some extent that tornadoes follow subterranean veins of water. That they are repeated in certain localities, have a fondness for belts of timber and small water-courses—provided they run in the right direction—there can be no doubt. They also travel over a portion of country previously moistened by rain. This rule has but few exceptions.

The increasing frequency and severity of these visitations (notwithstanding what may be said to the contrary) compel the writer to believe that radical changes are taking place in our atmosphere and climate; that the construction of great railroad-belts across the continent and the erection of a vast network of telegraph and telephone wires exert an influence upon the atmosphere, by disturbing the equilibrium of electric forces. The fact that tornadoes do not closely follow railroad and telegraph lines is not sufficient to disprove the soundness of this theory; and, whether true or false, the fact of the climatic change remains, and opens a vast field for further exploration by the electrician and the meteorologist.

Long-range predictions and weather forecasts may be safely indulged in, if made in a general way; but, when confined to fixed dates and certain localities, they have usually proved a hollow mockery, and brought ridicule upon the authors.

The United States Signal Service has proved to be quite reliable in its observations and predictions of approaching storms, and should receive due credit for its service rendered in protection of life and property. The benefits might be still further extended by a system of railway-express signals, operated in connection with it and by the direction of the Government observers at the different stations. Unfortunately, however, the warnings of this Service can not reach all concerned in time to be of value, nor can it protect in the hour of danger: as witness the tornado which visited the States of Texas, Mississippi, and Louisiana, on the 22d of April, in the present year, by which over one hundred persons lost their lives; also those which swept over a portion of the States of Missouri, Illinois, and Wisconsin, on the memorable evening of May 18, 1883. By this storm, sixty-five persons were killed and two hundred wounded in the State of Illinois alone; and yet the percentage of lives lost was small compared with the immense value of property destroyed.

As the matter now stands, the tornado seems to remain a problem that baffles science—a veritable despot in the economy of nature. The puny arm of man is powerless against it; no structure he can rear will successfully resist it, coming off unscathed in the conflict; and no device his mind can plan will turn it aside from its chosen course. Experience has amply demonstrated that the safest place in the hour of such danger is found in some subterranean retreat.

HOW THE EARTH WAS PEOPLED.

By M. le Marquis G. de SAPORTA.

II.

IT follows from the exposition given in our former article that man, issuing from a "mother-region" still undetermined, but which a number of considerations indicate to have been in the North, has radiated in several directions; that his migrations have been constantly from north to south; and that they have given rise to races the more ancient of which went farthest and were the most inferior. The superior races were those which, migrating later and becoming localized in peculiarly favorable climatic conditions, have risen gradually to what we call civilization.

M. de Mortillet has occupied himself with this progress, and, persuaded that existing mankind is only a resultant, and the last term of a series of successive transformations, distinguishes between several men, as tertiary man, quaternary man, existing man. The man of the ancient quaternary, the Neanderthal, the Denise, and the Canstadt man, appear to him so different from the historical type, that not only does he separate them from it, but he creates for the times anterior to the quaternary a human or pseudo-human category of a particular order. There were, in his view, "precursors of man," to which he applies the significant name of *anthropopithecus*, or "man-monkey," because he believes they preceded man in the scale of beings, and constituted an intermediate type between the living anthropomorphic apes and man. We should then have to deal with a creature high enough above the gorilla and the chimpanzee to know how to cut flints and use fire, low enough not to be able to rise above that industrial grade and become a real man; or with a race standing to the Bushman and Tasmanian as they seem to stand to us. Theology does not absolutely repel this view, for it discusses the possible existence of preadamites. Religion even seems disinterested in the question, for the Abbé Bourgeois, whose discoveries have given rise to M. de Mortillet's anthropopithecuses, and who has not rejected the theory, has always passed for a soundly orthodox priest, while he is known to be a keen observer. Nothing is against an impartial examination of the question. Only the objections may be offered to his views that no one has ever seen an anthropopithecus, the structure and characteristics of which have been worked out by pure reasoning alone, and that the distance that must have separated the precursor of man from man himself is calculated upon the extremely uncertain basis of the distance between quaternary and existing man.

According to M. de Mortillet's admission, quaternary man was himself gradually modified. "His blood," he says, "was infused into the new race, and may even reappear by atavism in our own times." The question is reduced to one of learning whether there existed in Europe, alongside of the miocene anthropomorphs of St. Gaudens, a primitive and rudimentary man of unknown physical qualities, who had industrial instinct enough to cut flints for his use. We are thus brought to the inquiry whether the instruments collected at Thénay by Abbé Bourgeois, and those discovered afterward in Portugal, in more recent but unquestionably tertiary formations, are authentic, or are not simple flakes and natural fragments that have been confounded with articles intentionally fabricated. Thénay, where the earlier of these flints were discovered, is in the Lower Miocene, an inferior formation to that of Sansan, in which the anthropomorphic fauna we have spoken of were included. The existence of the rhinoceros at the time of its formation is still in doubt, the mastodons had not yet appeared, the elephants were still far off; the hipparions, the predecessors of the horse, were not to make their appearance till long afterward. The marsupials had disappeared, and the carnivora were represented only by ambiguous types. None of the animal forms that were to accompany the earlier steps of man, and which he would have to contend against or tame, had showed themselves. Yet man is to be placed, in this rudest condition of nature, already in possession of fire! There is certainly little *a priori* probability of this. To be convinced of it, we need more evidence than has yet been presented to us—a few flints among many thousands of others, that may have been intentionally chipped. This is a little, but not enough, in view of the improbabilities which accumulate, against our putting faith in such indications.

The tertiary flints of Portugal are not calculated to add strength to the conviction. They come from an unquestionably tertiary freshwater formation of the recent Miocene age. The Portuguese flora of the age was characterized by the presence of elms, poplars, cinnamon-trees, saponarias, and tamarinds, which testify to a mild and equable climate throughout Europe, in which man would have found conditions most favorable to his development. When, however, we undertake to establish his existence there, we have in evidence only a deposit of sandstone mixed with silicious pebbles, partly disaggregated, which have been submitted to subsequent erosions and atmospheric influences that sufficiently explain the numerous fragments scattered over the ground from which those believed to have been intentionally cut have been sifted after a long search. M. Cazalis de Fondouce, who was a member of the Prehistoric Congress at Lisbon in 1880—a man of acknowledged competence in such matters—visited the miocene beds of Monte Redondo, and justifies his reservation of opinion on the character of the very few flints which it is possible to assimilate with those of the Moustier period, by reference to the denudations and disturbances the beds have suffered. It is not impossible that the stones were cut by man. One of them appears to have been taken from a bed that had not been disturbed; but, if this is admitted, is it not better to wait, than to attempt to solve so great a problem at once and without direct proof? M. de Mortillet is himself wise enough not to affirm directly anything but the authenticity of the instruments. He adds that their small size leads him to believe that the beings that made them, if of proportionate dimensions, were not and could not have been real men. The doubt which he admits respecting the creatures whose intervention he invokes, we extend to the instruments, and wait for the results of future discoveries to resolve it.

Acceptation of these relics as evidences of a tertiary man is made more difficult by the bright light of the following period, which M. de Mortillet calls "Chellean," from the station of Chelles, near Paris, which he regards as typical of it. Man reveals himself in this epoch with an evident industry—primitive, for it presents only a single category of instruments, which are, however, so clearly characterized by their form and size that the most prejudiced mind could not fail to recognize them at once as belonging to the same race. The deposit of Chelles is even more characteristic than that of St. Acheul, where similar instruments have been found in so great numbers. The *Elephas antiquus* of Falconer, the probable ancestor of the Indian elephant, and the predecessor of the mammoth in Europe, is found exclusively at Chelles, associated with human implements, while at St. Acheul the mammoth is more frequently found, although the other species is not absent. Thus, Chellean man saw two species of elephants merge one into the other. Probably, also, the climate changed insensibly and became colder, without disturbance to his habits or his industry. In the long run, however, the action of the physiological and biological events of which Europe became the theatre had an influence on quaternary man; and the Chellean race, passing into that of Moustier, gradually changed its habits, while it learned to fashion other instruments. There need have been nothing abrupt in this evolution, which was the product of the exigencies of a climate gradually growing more severe. At the beginning, the animals, plants, and air were those of Northern Africa, and the conditions for human existence were of the best. The Chellean man lived in the open air, or possibly under light shelters, but did not resort to caves, and was not accustomed to bury his dead. These facts explain the abundance of instruments of that age in alluvial deposits, their absence from the caves, which served as places of refuge in the following ages, and the extreme rarity of bones. The great numbers of the implements found in different parts of France give the idea of an active population of considerable density, whose peaceful extension was not interrupted during long ages by any unfortunate event. The race may be traced by means of identical instruments, except that the materials vary according to the resources of the different countries, in Spain, Portugal, Italy, Algeria, and Egypt, and even at the Cape of Good Hope; and, in North America, in the valley of the Delaware, New Jersey, and the Bridger Basin, Wyoming. The uniformity of the instruments is a most striking feature. Always the same in design, they were made to serve for more than one use—a merit, probably, in the eyes of the men who chipped them out, but a sign of inferiority in the race which, for thousands of years, knew how to make these and no other tools. They were not, according to M. de Mortillet, real hatchets, as they have been commonly called, but simply a tool (*coup de poing*), to be held bodily in the hand, and used according to the need, as hatchet, knife, chisel, or gouge. The weapon of the race was a club, and of that all traces have, of course, vanished.

The slow development of the division of labor seems to have been reserved for the following age, that of Moustier, which joins closely upon the Chellean age, and, while less perfect in details, evidences more skill and rapidity in processes, and a more utilitarian spirit. Its implements are more varied and specialized in their forms. The climate had become more severe; the glaciers were approaching their greatest extension; and "Moustierian man" was obliged to take refuge in caverns, where the relics of his industry are as frequent as those that occur scattered over the soil. In other respects the race and epoch of Moustier seem to have been simply a prolongation of those of Chelles. Only man, under pressure of new necessities, experienced wants he had not previously known. He had to be more industrious. Large animals had become more numerous; he had to arm himself for defense, and became a hunter.

As no pains were taken to give the dead a permanent burial, we can not expect to find many bones of these most ancient races. Possibly their dead were exposed, as those of some Indian tribes are now, and that would be an additional reason why their remains should have utterly disappeared. Leaving out the doubtful relics, M. de Mortillet finds only a very few bones that can possibly be ascribed to the

Chellean epoch. They belong to the race which MM. de Quatrefages and Hamy have determined, from purely anatomical considerations, as the Canstadt race, after the skull found at that place associated with elephants' bones in 1700. This skull, the Eguisheim skull (near Colmar), the fragments from Denise, the Neanderthal skull, and the *la Noulette* jawbone, are all that we have of it, and they are, it must be acknowledged, very little. They are enough, however, to give the clew to its general features, and to show its inferiority to the Bushmen and Australians, more marked, according to M. de Mortillet, than the differences between those races and the Europeans. M. de Mortillet believes that the Neanderthal man was violent and pugnacious, and goes so far as to deny him articulate speech. But we can not indulge in such bold conjectures on so little evidence. We know nothing more of the primitive European man, or of his fate. His simultaneous extension over so large a number of points gives occasion for the thought that originally, at least, he represented, not a particular race, but the common stock, in which modifications were destined to be made according as it became localized and specialized under the influence of the extremely varied conditions of the medium in which it found itself at different places. The Neanderthal man was, then, the original of what has followed. Advancing toward the south, he has peopled the earth, and been divided into local races and tribes. The Moustier epoch illustrates in Europe the stage following the first one; and the periods following that of Moustier, which M. de Mortillet has named Solutrean and Magdalenean, from the typical stations at Solutré and la Madeleine, correspond with the times when man, having localized himself, underwent gradual transformations, assuming in different respects the specific characteristics that distinguish those races, developing aptitudes as diverse as the places in which he fixed himself, and stopping at unequal and successive steps of the ladder which he was destined to climb, but which was to lead him to the full exercise of his noblest faculties only on condition of his reaching its highest rounds.

The Solutrean age was only one of rapid transition to the Magdalenean, and appears to have represented a local rather than a secular development. Both ages are the expression of the increasing cold of the glacial period, during which the huge pachyderms gradually disappeared under the growing rigor of the climate, and the reindeer and horse multiplied to take their places. The reindeer came down to occupy Central Europe, without reaching the southern regions, in numerous varieties, all of which, however, were allied to the existing reindeers of Lapland. Of the horse, at least twenty thousand, possibly forty thousand skeletons, have been found at Solutré. Neither of these animals was then domesticated, and the dog was still unknown. Man secured animals by hunting, either killing them on the spot or binding them to take home. The mammoth had become a kind of legendary being, hidden in the deepest forests, an object of curiosity, abundant enough to furnish ivory, and to provoke the man of the time to execute drawings of him. In fact, the man of this age had made great progress. The division of industrial labor had become efficient. The cutting of the flints had attained great perfection and delicacy, and a new branch of industry had been added to it; bone was worked, with ivory and reindeer-horn. Both the instruments and the substances of which they were made were now specialized. We have seen points of javelins and darts artistically worked on both faces, and prepared for handles; the scrapers were no less appropriately fitted to the use to which they were exclusively applied. Of bone were made needles, harpoons, and at last purely ornamental articles, sculptures, and engravings. Some of the representations give us curious details concerning the man and the animals of the epoch. The reindeer, bear, and mammoth were figured. The man is always naked, or appears to be. We distinguish the figure of a woman, whose body seems covered with hair; but this may only indicate garments of skins. One of the figures represents a man walking with a club over his shoulder. Men also become differentiated by localization, and the Magdalenean man offers us one of the earliest instances in Europe of this effect. The Solutrean race, whose spear-heads are so finished, and the more recent and more artistic race of the caves of Périgord, whose simple designs and efforts in sculpture we admire, show us the first essays of that spirit of initiative and of relative progress, which, after localization, conducted some of them to material inventions and ideal conceptions, and by these to the region of that supreme culture of all our faculties which we call civilization.

As M. de Mortillet shows, the man of la Madeleine was a hunter, active, ingenious, and susceptible to sentimental impressions from living nature. He had a home, and joys and sorrows; he held his hunting-feasts, and knew how to procure a kind of enjoyment with the aid of the arts of imitation and ornamentation. He recognized rank and a hierarchy, for he possessed emblems of honor and insignia of command. But this was all. He had no agriculture, no domestic life; and, if those men had any particular way of disposing of their dead, it was by exposure in the open air; and this is probably the reason that so few of their remains are found.

Is there any way in which we can determine the physical traits and osteological structure of this Magdalenean race? The numerous remains found at Cro Magnon in connection with articles of the Magdalenean age were thought to belong to the artistic race of Périgord; but M. de Mortillet discredits this opinion by showing that the places where these remains occur were disturbed in the succeeding period, the Robenhausian, and that the burials, unknown to the Magdaleneans, were practiced by those who came after them.

To M. de Mortillet, the European Magdalenean race was only a modified prolongation of that of Chelles and Moustier. Mixtures by migration and the co-existence of several races having differently shaped skulls were posterior to the recent quaternary and to the extinction of the mammoth and the retreat of the reindeer to the north. Then came an age in which, the climate having undergone amelioration, the glaciers having retired to the foot of the mountains, and the sea having withdrawn from Northern Europe to within its present limits, a new era was inaugurated. This was the era of continuous development and activity, the progress of which at last leads us step by step to the invention of metals and to history proper. The last period, however, includes many sub-periods. The metals were still unknown for a long time, and stone continued to be the only material used in making working-tools. A few arts, the necessary point of departure for all society, had, however, begun to be exercised: among them were the domestication of useful animals, beginning with the dog; agriculture, and consequently the adoption of some of the food-plants; the use of pottery; and, finally, the grouping of men and their habitations in view of common defense, and also of the observance of religious rites. To an age of this kind, which has left a host of points in Europe, from Scandinavia to Switzerland, and from the heart of France to Southern Italy, M. de Mortillet has given the name Robenhausian. To follow it on this new ground through its progress to the age of bronze, would require the consideration of details that would carry us too far. It was the age of the dolmens and of the lake-villages; in it man was beginning to grow out of his infancy. Although, at least in Europe, he was not acquainted with the use of metals, and possessed only a rudimentary agriculture and industry, and although his food was still scanty and his existence precarious, he had already begun to sow wheat and barley; he wove coarse linen cloths; he made vessels of pottery and hardened them in the fire; and he built real monuments to his dead, artificial representations of caves made by piling rough stones together. Religious rites and invocations, a kind of luxury in furniture, and medical and surgical processes, came in vogue. We feel that we are on the verge of great inventions and of gigantic efforts, tending to enlarge the formerly extremely narrow circle of knowledge and of processes.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M. D.

THE ALCOHOL-HABIT.

I.

IN the tragedy of errors, called the history of the human race, ignorance has often done as much mischief as sin; and the erroneous theories of the cause—and, consequently, the proper cure—of the *Poison-Vice* have caused nearly as much misery as that vice itself. They have made intemperance an all but incurable evil; they have helped to originate the dogma of natural depravity, the confidence in the efficacy of anti-natural remedies, and that baneful mistrust in the competence of our natural instincts that still vitiates our whole system of physical education.

Physiology is a true thaumaturgic science—a description of wonders. The veriest savage must dimly recognize the fact that man can not measure his cunning against the wisdom of the Creator, and, if the development of science should continue at the present rate of progress for a thousand generations, the accumulated knowledge of all those ages would convince its inheritors that a blade of grass is a greater marvel than all the products of human skill. No human artificer can imitate the mechanism of a motor-nerve; the structural devices which the microscope reveals in the tissue of the meanest moss are perfect hyperboles of wisdom and plastic skill. But the greatest miracles of that wisdom manifest themselves in the self-protecting contrivances of a living organism. Our nervous system performs its functions by a combination of alarm-signals that apprise us of an infinite variety of external dangers and internal needs, in a language that has a distinct expression for every want of our alimentary and respiratory organs, for every distress of our tissues, sinews, and muscles, for every needed reaction against the influence of abnormal circumstances; our skin protests against every injurious degree of heat and cold, our lungs against atmospheric impurities, our eyes against the intrusion of the smallest insect; the human body is a house that cleanses its own chambers and heats its own stoves, opens and shuts its windows at proper intervals, expels mischievous intruders, and promptly informs its tenant of every external peril and internal disorder.

How, then, can it be explained that the wonderful architect of that living house has provided no better safeguard against such a dreadful danger as the alcohol-habit? Millions of our fellow-men complain that they owe their temporal and eternal ruin to the promptings of an irresistible appetite—as if Nature herself had lured them to their destruction. Temperance-preachers descant on the "danger of worldly temptations" and "selfish indulgence," on the "lusts of unregenerate hearts." Drunkards plead their willingness to reform, but "the flesh is stronger than the spirit," the clamors of instinct silence the voice of every other monitor. Does the power of such appetites not suggest the occasional incompetence of our natural intuitions? Does it not seem to confirm the dogma of natural depravity, and prove an essential defect in the constitution of our physical conscience? Nay, in the light of Nature, for reason too often fails to supply the shortcomings of instinct; the teachers whom the ignorant must follow seem themselves to be in need of a guide; the stimulant-vice has found learned and plausible defenders; zealous priests of Moloch have worshiped the man-devouring fire as a sacred flame; for thousands of honest truth-seekers the disagreement of doctors makes it doubtful if alcohol is a friend or a foe, a health-giving tonic or a death-dealing poison.

Does all this not prove that, in one most important respect, Nature has failed to insure the welfare of her creatures?

What it really proves is this: That habitual sin has blunted our physical conscience till we have not only ceased to *heed*, but ceased to *understand*, the protests of our inner monitor; it proves that the victims of vice have so utterly forgotten the language of their instincts that they are no longer able to distinguish a natural appetite from a morbid appetency.

For the Creator has not intrusted our physical welfare to accident or the tardy aid of science, and, in spite of the far-gone degeneration of our race, our children still share nearly all the protective instincts of the Nature-guided animals. Children abhor the vitiated air of our city tenements; they need no lecturer on practical physiology to impress the necessity of out-door exercise; their instinct revolts against the absurdities of fashion and the unnatural restraints of our sedentary modes of life. And the same inner monitor warns them against dietetic abuses. Long before Bichat proved that our digestive organs are those of a frugivorous animal, children preferred apples to sausages and sweetmeats to greasy made-dishes; they detest rancid cheese, caustic spices, and similar whets of our jaded appetites. No human being ever relished the first taste of a "stimulant." To the palate of a healthy child, tea is insipid; the taste of coffee (unless disguised by milk or sugar) offensively bitter, laudanum acrid-caustic; alcohol as repulsive as corrosive sublimate. No tobacco-smoker ever forgets his horror at the first attempt, the seasick-like misery and headache—Nature's protest against the incipience of a health-destroying habit. Of lager-beer—"the grateful and nutritive beverage which our brewers are now prepared to furnish at the rate of 480,000 gallons a day"—the first glass is shockingly nauseous—so much so, indeed, as to be a fluid substitute for tartar emetic. Nor do our instincts yield after the first protest: nausea, gripes, nervous headaches, and gastric spasms, warn us again and again. But we repeat the dose, and Nature, true to her highest law of preserving existence at any price, and feeling the hopelessness of the life-endangering struggle, finally chooses the alternative of palliating an evil for which she has no remedy, and adapts herself to the abnormal condition. The human body becomes a poison-engine, an alcohol-machine, performing its vital functions only under the spur of a specific stimulus.

And only *then* the unnatural habit begets that craving which the toper mistakes for the prompting of a healthy appetite—a craving which every gratification makes more exorbitant. For by-and-by the jaded system fails to respond to the spur; the poison-slave has to resort to stronger stimulants; rum and medicated brandy now mock him with the hope of revived strength; the gathering night still gives way to an occasional flickering-up of the vital flame, till the nervous exhaustion at last defies every remedy: the worshiper of alcohol must consummate his self-sacrifice, the shadow of his doom has settled on his soul, and all the strongest stimulants can now do for him is to recall a momentary glimmering of that light which filled the unclouded heaven of his childhood.

In order to distinguish a poison-stimulant from a harmless and nutritive substance, Nature has thus furnished us three infallible tests:

1. *The first taste of every poison is either insipid or repulsive.*

2. *The persistent obtrusion of the noxious substance changes that aversion into a specific craving.*

3. *The more or less pleasurable excitement produced by a gratification of that craving is always followed by a depressing reaction.*

The first drop of a wholesome beverage (milk, cold water, cider fresh from the press, etc.) is quite as pleasant as the last; the indulgence in such pleasures is not followed by repentance, and never begets a *specific craving.* Pancakes and honey we may eat with great relish whenever we can get them, but, if we can't, we won't miss them as long as we can satisfy our hunger with bread and butter. In midwinter, when apples advance to six dollars a barrel, it needs no lectures and midnight prayers to substitute rice-pudding for apple-pie. A Turk may breakfast for thirty years on figs and roasted chestnuts, and yet be quite as comfortable in Switzerland, where they treat him to milk and bread. Not so the dram-drinker: his "thirst" can not be assuaged with water or milk, his enslaved appetite craves the wonted tipple—or else a stronger stimulant. Natural food has no effect on the poison-hunger; Nature has nothing to do with such appetites.

The first choice of any particular stimulant seems to depend on such altogether accidental circumstances as the accessibility or cheapness of this or that special medium of intoxication. Orchard countries use distilled or vinous tipples; grain-lands waste their products on malt-liquors. The pastoral Turkomans fuddle with *koumiss*, or fermented mare's-milk, the Ashantees with sorgho-beer, the Mexicans with pulque (aloe-sap), the Chinese and Persians with opium and hasheesh (*Cannabis Indica*), the Peruvians with the acrid leaves of the coca-tree. Even mineral poisons have their votaries. There are thousands of arsenic-eaters in the southern Alps. Arsenious acid, antimony, cinnabar, and acetate of copper, are mistaken for digestive tonics by Spanish and South American miners. By the process of fermentation, rice, sago, honey, sugar, durrha (*Sorghum vulgaris*), dates, plums, currants, and innumerable other berries and fruits, have been converted into stimulants. The pastor of a Swiss colony on the Llanos Ventosos in the Mexican State of Oaxaca told me that the Indians of that neighborhood stupefy themselves with macerated *cicuta*, a kind of water-hemlock, and remarked that the delirium and the subsequent reaction of a cicuta-debauch correspond exactly to the successive phases of a whisky-spree, the only difference being in the price of the tipple. If intoxication were a physiological necessity, it would, indeed, be folly to buy the stimulant at the dram-shops, since cheaper poisons would serve the same purpose. A dime's worth of arsenic would protract the stimulant-fever for a week, with all the alternate excitements and dejections of an alcohol-revel. A man might get used to phosphorus and inflame his liver with the same lucifer-matches he uses to light his lamp; we might gather jimson-weed or aconite, or fuddle with mushrooms, like the natives of Kamchatka, who prepare a highly-intoxicating liquor from a decoction of the common fly-toadstool (*Agaricus maculatus*).

These facts teach us two other valuable lessons, viz., that *every poison can become a stimulant*, and that *the alcohol-habit is characterized by all the symptoms which distinguish the poison-hunger from a natural appetite.* One radical fallacy identifies the stimulant-habit in all its disguises: its victims mistake a process of *irritation* for a process of *invigoration.* The self-deception of the dyspeptic philosopher, who hopes to exorcise his blue-devils with the fumes of the weed that has caused his sick-headaches is absolutely analogous to that of the pot-house sot who tries to drown his care in the source of all his sorrows; and there is no reason to doubt that it is precisely the same fallacy which formerly ascribed remedial virtues to the vilest stimulants of the drug-store, and that, with few exceptions, the poisons administered for "medicinal" purposes have considerably increased, instead of decreasing, the sum of human misery.

The milder stimulants (light beer, cider, and narcotic infusions) would be comparatively harmless, if their votaries could confine themselves to a moderate *dosis.* For sooner or later the tonic is sure to pall, while the morbid craving remains, and forces its victim either to increase the quantity of the wonted stimulant, or else resort to a stronger poison. A boy begins with ginger-beer and ends with ginger-rum; the medical "tonic" delusion progresses from malt-extract to

Munford's Elixir; the coffee-cup leads to the pipe, and the pipe to the pot-house. Wherever the nicotine-habit has been introduced, the alcohol-habit soon follows. The Spanish Saracens abstained from all poisons, and for seven centuries remained the teachers of Europe in war as well as in science and the arts of peace—freemen in the fullest sense of the word, men whom a powerful foe could at last expel and exterminate, but never subdue. The Turks, having learned to smoke tobacco, soon learned to eat opium, and have since been taught to eat dust at the feet of the Muscovite. When the first Spaniards came to South America they found in the Patagonian highlands a tribe of warlike natives who were entirely ignorant of any stimulating substance, and who have ever since defied the sutlers and soldiers of their neighbors, while the tobacco-smoking red-skins of the North succumbed to fire-water. In the South-Sea Islands, too, European poisons have done more mischief than gunpowder: wherever the natives had been fond of fermented cocoa-milk, their children became still fonder of rum; while the Papuans, whose forefathers had never practiced stimulation, have always shown an aversion to drunkenness, and in spite of their ethnological inferiority have managed to survive their aboriginal neighbors. International statistics have revealed the remarkable fact that the alcohol-vice is most prevalent—not in the most ignorant or most despotic countries (Russia, Austria, and Turkey), nor where alcoholic drinks of the most seductive kind are cheapest (Greece, Spain, and Asia Minor), but in the *commercial countries that use the greatest variety of milder stimulants*—Great Britain, Western France, and Eastern North America. Hence the apparent paradox that drunkenness is most frequent among the most civilized nations. The tendency of every stimulant-habit is toward a stronger tonic. Claude Bernard, the famous French physiologist, noticed that the opium-vice recruits its female victims chiefly from the ranks of the veteran coffee-drinkers; in Savoy and the adjoining Swiss cantons kirsch-wasser prepares the way for arsenic; in London and St. Petersburg many ether-drinkers have relinquished high wines for a more concentrated poison; and in Constantinople the Persian opium-shops have eclipsed the popularity of the Arabian coffee-houses.

We see, then, that *every poison-habit is progressive*, and thus realize the truth that there is no such thing as a harmless stimulant, because the incipience of every unnatural appetite is the first stage of a progressive disease.

The facts from which we draw these conclusions have long been familiar to scientific specialists, and have separately been commented upon; but in science, as in morals, the progress from special to general inferences is often amazingly slow. The ancient Athenians would have shuddered at the idea of selling and buying a burgher of their own city, but had no hesitation to enslave the Greeks of the neighboring states. The Romans enfranchised the citizens of Latium, and at last all the natives of the Italian Peninsula, but kidnapped all the "barbarians" they could lay their hands upon! The French and Spaniards of the last century were deeply shocked at the indiscriminate man-hunts of the Algerian corsairs, and even refused to retaliate on the men of Argel, because, in spite of their black turpitude, many of those misbelievers had something like a Caucasian skin on their faces, but those same moralists thought it perfectly proper to kidnap and cowhide the black sons of Ham; but, since the children of a negress were as salable as their mothers, and miscegenation and mistakes could not always be avoided, it sometimes happened that the auctioneer got hold of a white slave, till William Wilberforce at last arrived at the grand conclusion that all human slavery is wrong. More than a hundred years ago, Dr. Boerhaave entered an emphatic protest against rum, French high-wines, and "other adulterated spirits," but confessed a predilection for a drop of good *Schiedam*. Dr. Zimmermann objected to all distilled liquors, but recommended a glass of good wine, and a plate of beer-soup—the latter a Prussian invention, and one of those outrages on human nature that embittered the childhood of Frederick the Great. The hygienic reformers of our own country denounce intoxicating drinks of all kinds, but connive at mild ale, cider, opiates, narcotics, and patent "bitters." The plan has been thoroughly tried, and has thoroughly failed. We have found that the road to the rum-shop is paved with "mild stimulants," and that every bottle of medical bitters is apt to get the vender a permanent customer. We have found that cider and mild ale lead to strong ale, to lager-beer, and finally to rum, and the truth at last dawns upon us that the only safe, consistent, and effective plan is Total Abstinence from all Poisons.

We have seen that the poison-habit is a upas-tree that reproduces its germs from the smallest seeds; but where did the first seed come from? How did the life-blighting delusion happen to take root in the human mind? "Man is the only suicidal animal," says Dr. Haller, "and the first opium-eater was probably some life-weary wretch who tried to end his misery by a lethal dose, and found that his poison could be used as a temporary nepenthe." The physiologist Camper ascribes the introduction of alcoholic liquors to the experiments of unprincipled physicians; but the most plausible theory is the conjecture of Fabio Colonna, an Italian scientist of the seventeenth century. "Before people used wine," says he, "they probably drank sweet must, and preserved it, like oil, in jars or skins. But in a warm climate a saccharine fluid is apt to ferment, and some avaricious housekeeper may have drunk that *spoiled* stuff till she became fond of it, and thus learned to prefer wine to must." Not a compliment to human nature, but quite probable enough to be true. An animal would have preferred water to spoiled grape-juice, but even at a very early period of his development the Nature-despising *homo sapiens* may have learned to disregard the warnings of his instinct. The economical housekeeper probably thought it a shame that his (giving poor Eve the benefit of the doubt) servants should grumble about a slight difference in the taste of the must, and the servants had to submit, had to drink the "spoiled stuff" again and again, till habit more than neutralized their disgust, for they found that the sickness induced by the effects of the putrefaction-poison (alcohol) could be cured by a repetition of the dose. They began to hanker after fermented must, and, by drinking it in larger quantities, induced a delirium which they described as anything but unpleasant; and their master, after repeated experiments, probably arrived at the same conclusion, namely, that must could be improved by fermentation. The next year they gathered grapes for the deliberate purpose of manufacturing an intoxicating drink, and the fatal precedent was established. Nature exacted the just penalties: the votaries of the poison-god were stricken with physical and mental nausea—weariness, headaches, fits of spleen and hypochondria—but still they found that all these symptoms could be temporarily relieved by a draught of fermented must; and the neighbors were astonished to learn that the servants of Goodman Noah had discovered a panacea for all earthly afflictions. They, too, then tried the receipt—with indifferent success at first, but the experience of the *habitués* encouraged them to persist, till the manufacture of *wine* became an extensive business.

The first traffickers in stimulants (like our lager-beer philanthropists) had a personal interest in disseminating the habit, but, whatever may have been the birth-land of the alcohol-vice, its first growth was probably slow, compared with the rate of increase after its exportation across the frontier. The history of tobacco, tea, coffee (and opium, I fear), has repeatedly illustrated the influence of *imitativeness* in promoting the introduction of foreign vices. The rarity and novelty of outlandish articles generally disposes the vulgar to value them as luxuries, especially while a high price precludes their general use. Foreign merchants and a few wealthy natives set the fashion, and soon the lower classes vie in emulating their betters, the young in aping their elders. In England, James I tried his utmost to suppress the use of smoking-tobacco, but, after his young cavaliers had become addicted to the habit, no penalties could prevent the London apprentices from imitating them. "In large cities," says Dr. Schrodt, "one may see *gamins* under ten years grubbing in rubbish-heaps for cigar-stumps, soon after leaning against a board-fence, groaning and shuddering as they pay the repeated penalty of Nature, but, all the same, resuming the experiment with the resignation of a martyr. The rich, the fashionable, do it; those whom they envy smoke: smoking, they conclude, must be something enviable."

Similar arguments, doubtless, aided the introduction of the alcohol-habit, and, after the vice had once taken root, its epidemic development followed as a matter of course. Every poison-vice is progressive, and, soon after the introduction of a new stimulant, the majority of individual consumers will find that the habit "grows upon them," as our language aptly expresses it. The direct effect of the poison, hereditary influences, etc., induce a growing depression of vital energy, which, in turn, leads to an increased demand for the means of stimulation. This want is met in a twofold way: 1. By a direct increase of the quantity or strength of any special stimulant; 2. By the progress from a milder to a more virulent poison of a different kind.

In Prussia, Scotland, Denmark (as well as in some of our Eastern States), actual drunkenness (i. e., intoxication followed by riotous conduct) has apparently decreased, while the revenue register shows an undoubted increase in the *per capita* consumption of alcoholic liquors. This does not prove that our topers are growing less vicious, but that they are growing more practical; intermittent rioters have become "steady hard-drinkers." In the Calmuck *steppes*, whose barrenness has forced the inhabitants to preserve the primitive habits of their ancestors, a little grain is cultivated here and there in the river-valleys, and during the winter migration the herders carry bags full of rye from camp to camp, and bake bread whenever they are short of meat or milk. But at the return of the harvest-season they have both meat and bread, and utilize the surplus of last year's grain by brewing it into a sort of beer, and indulging in a grand carousal—i. e., they get beastly drunk, but only once a year. The Bacchanalia and Symposia of the ancient Greeks were monthly revels in honor of some favorite deity; and even during the middle ages many of the poor Scotch lairds brewed ale only when they expected a guest. To get "as drunk as a lord" was the highest ambition of poor Hodge, but an ambition which he could not often gratify, though he sometimes stinted himself in bread in order to drink his fill—

"At ember-eves and holy ales."

By-and-by, however, wages improved, and *ales* became more frequent and more decidedly unholy, though perhaps less obstreperous, since continual practice enables our topers to "carry their liquor" as discreetly as the Baron of Bradwardine. The most respectable hotel in Geneva, Switzerland, allows its male employés a daily *pour boire* of six quarts of wine; Dr. Buchanan, of Manchester, speaks of English mechanics of the "better class" who take a glass of gin with every meal; and I am sure of understating the truth if I say that in the larger cities of Germany and North America every popular beer-shop has among its customers dozens of "regulars" who drink the year round a daily *minimum* of two gallons of lager-beer. The poison-mania which attacked our ancestors in the form of an intermittent passion has grown into an insatiable hunger; the tempting serpent has become a strangling hydra.

And the heads of that hydra have multiplied. The ancient Greeks knew only one stimulant—wine; the Northmen beer, the American Indians tobacco. We have adopted all three, besides tea from China, opium from India, coffee from Arabia, and fire-water from the laboratory of the German chemists. To this list the modern French have added chloral and *absinthe*. Yet this multiformity of the poison-habit is nothing but a normal symptom of its growth; whenever the quantitative increase of a stimulant-dose has reached its physical limits, the exhausted system craves a new tonic; the beer-drinker rallies his nerves with strong coffee, tobacco, or hot spices (pepper-sauce, "herring-salad," etc.), the brandy-drinker with chloral or opium, the opium-eater with arsenic. "It is alcohol that has led me to opium," says Charles Nisard; "at first I used laudanum only as an antidote."

Antidote means counter-poison. Supplementary poison would have been the right word; foreign poison-habits have supplemented rather than superseded our old stimulant-vices. The brewers' argument, that the use of lager-beer would prevent the introduction of opium, is therefore a bottomless sophism: no stimulant-vice has ever prevented the dissemination of other and stronger poisons. The alcohol-habit has sometimes been supplanted by a passion for opium, chloral, or arsenic, but it can not be exorcised with a weaker stimulant. Beelzebub does not yield to a hobgoblin. Yet nothing is more common in temperance-hospitals than to comfort a converted drunkard with strong black coffee or stimulating drugs, in the hope that the milder tonic might operate as a sort of antidote and neutralize the after-effects of the stronger poison. That idea is an unfortunate delusion. The *succedaneum* may bring a temporary relief, but it can not assuage the thirst for the stronger tonic, and only serves to *perpetuate the stimulant-diathesis*—it prepares the way for the return of Beelzebub with a legion of accomplices. On the total-abstinence plan the struggle with the fiend is sharper, but decisive. If, by the help of a strong physical (or moral) constitution, the drunkard can suppress his appetite for a year, he may manage to keep it afterward in a dormant condition; but only with extreme precaution, for a mere spark is apt to rekindle the flame.

"It should ever be borne in mind," says Dr. Sewall, "that such is the sensibility of the stomach of the reformed drunkard, that a repetition of the use of alcohol, in the slightest degree and in any form, under any circumstances, revives the appetite; the blood-vessels of the stomach again become dilated, and the morbid sensibility of the organ is reproduced."

A young priest from one of the West India Islands once consulted Dr. Rush for an affection of the lungs, and was advised to try the use of garlics. "I am satisfied that your prescription is doing me good," said he at the next interview, "but I wish you would let me steep it in some good old Geneva." "No, indeed, sir!" said the doctor, with emphasis; "no man shall look me in the face, on the day of judgment, and tell the Almighty that Dr. Rush made him a drunkard!"

I do not intend to deny that the use of mild alcoholic tonics, as a substitute for the frightful remedies of the mediæval Sangrados, is a decided improvement, but, still, it is only a lesser evil, a first step of a progressive reform. Alcohol lingers in our hospitals as slavery lingers in the West Indies, as the witchcraft delusion lingers in Southern Europe. Has alcohol any remedial value whatever? Let us consider the matter from a purely empirical stand-point. Does alcohol protect from malarial fevers? It is a well-known fact that the human organism can not support two diseases at the same time. Rheumatism can be temporarily relieved by producing an artificial inflammation; a headache yields to a severe toothache. For the same reason the *alcohol-fever* affords a temporary protection from other febrile symptoms—i. e., a man might fortify his system against chills and ague by keeping himself constantly under the stimulating influence of alcohol. But sooner or later stimulation is followed by depression, and during that reaction the other fever gets a chance, and rarely misses it. The history of epidemics proves that pyretic diseases are from *eight* to *twelve* times more destructive among dram-drinkers than among the temperate classes; rich or poor, young or old, abstainers are only *centesimated* by diseases that decimate drunkards. On no other point is the testimony of physicians of all schools, all times, and all countries, more consistent and unanimous.

Is alcohol a peptic stimulant? No more than Glauber's-salt or castor-oil. The system hastens to rid itself of the noxious substance, the bowels are thrown into a state of morbid activity only to relapse into a morbid inactivity. The effect of every laxative is followed by a stringent reaction, and the habitual use of peptic stimulants leads to a chronic constipation which yields only to purgatives of the most virulent kind.

Does alcohol impart strength? Does it benefit the exhausted system? If a worn-out horse drops on the highway, we can rouse it by sticking a knife into its ribs, but, after staggering ahead for a couple of minutes, it will drop again, and the second *deliquium* will be worse than the first by just as much as the brutal stimulus has still further exhausted the little remaining strength. In the same way precisely alcohol rallies the exhausted energies of the human body. The prostrate vitality rises against the foe, and labors with restless energy till the poison is expelled. Then comes the reaction, and, before the patient can recover, his organism has to do double work. Nature has to overcome both the original cause of the disease and the effect of the stimulant.

Alcohol has no remedial value. But that would be a trifle, if it were not for the positive mischief which the wretched poison is liable, and very liable, to cause. Four repetitions of the stimulant-dose may inoculate a child with the germs of the alcohol-diathesis and initiate a habit which years of anguish and despair will fail to cure. By a single glass of medicated brandy thousands of convalescing topers have lost their hard-earned chance of recovery; poor, struggling wretches, swimming for their lives, and, at last approaching a saving shore, have been pushed back into the surging whirlpool, and perished almost in sight of the harbor! The only chance of curing the poison-habit consists in the hope of guarding its victims against all stimulants; and I would as soon snatch bread from a starving man as that last hope from a drunkard.

Abstinence is easier, as well as safer, than temperance. "In freeing themselves from the bonds of an unworthy attachment," says Madame de Sévigné, "men have one great advantage—they can travel." If young Lochinvar's suit had been hopeless, the furtive interview with his lost love might have soothed his sorrow for a moment, but for his ultimate peace of mind it would have been better to stay in the west. The anchorites of old knew well why they preferred the wilderness to the humblest village: they found it easier to avoid *all* temptations. Vices, as well as virtues, are co-operative.

In the cure of the alcohol-habit, the total renunciation of all stimulants is, therefore, the first and most essential measure. A change of diet, a change of climate, of employment, and general habits, will help to shorten the distressing reaction that must precede the re-establishment of perfect health. The force of example may partly supply a deficiency in moral principles, ambition may strengthen their influence. But the effect of any secondary stimulant is more than enough to counteract such tendencies. With the following precautions the total-abstinence plan will prove to have the further advantage of progressive effectiveness; for, after the removal of the irritating cause has in some degree allayed the morbid sensitiveness of the digestive organs, the abnormal appetite will gradually disappear, like the secondary symptoms of the disease, and thus lessen the influence of the subjective temptation.*

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THE AIM OF THERMO-CHEMICAL INVESTIGATIONS.

By JULIUS THOMSEN.†

THEORETICAL chemistry is based upon the molecular theory, according to which all matter is made up of molecules, and these molecules of atoms. The physical state of bodies depends upon the arrangement and motions of the molecules; the other physical and chemical properties depend upon the kind and number of the atoms in the molecule, upon their arrangement and relative motions.

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* The treatise on "The Alcohol-Habit" will be concluded in our next issue.

† Translated from the introduction to Thomsen's "Thermochemische Untersuchungen," Leipsic, 1882, by W. R. Nichols.

Every action which causes a change in the internal structure of the molecules is a chemical action. These changes may be of various sorts: either there takes place simply a change of position among the atoms of the molecule and there is then formed a body which is isomeric or metameric with the original substance; or the molecule is broken up into several molecules, and the process is then one of dissociation, or of simple decomposition; or, further, several molecules unite together to form a single molecule, in which case the process is spoken of as one of condensation or addition; or, finally, molecules act upon each other with interchange of atoms and formation of new molecules, which is the phenomenon of mutual decomposition, the most common sort of chemical action.

From the doctrine of the conservation of matter, it follows that the mass of the bodies which take part in any chemical reaction does not change, and is fully accounted for in the products of the reaction: this principle forms the foundation for quantitative chemical investigations into the composition of substances.

From the principle of the conservation of energy, it follows, in like manner, that no energy is lost or created, and that, consequently, the whole of the energy originally present in the bodies, which act upon each other, appears again in the products of the chemical reaction, although often in a different manner than before. This principle forms the foundation of all quantitative thermo-chemical investigations.

The energy of a molecule is always the same at the same temperature; any increase or diminution of the energy of the molecules, without change of their internal structure, manifests itself as an elevation or a lowering of the temperature of the substance in question.

By chemical action, the structure of the molecule is changed, the atoms become grouped together in a different way, new relations manifest themselves among them, and the energy of the new molecule becomes different from that of the original one. The simplest case is that where the only change is in the grouping and the motions of the atoms of the same molecule, that is where an isomeric compound is formed; in such a case the atoms of the molecule pass from one condition of equilibrium to another, and, according as the new condition of equilibrium answers to a greater or less stability than the original, there occurs either an evolution or an absorption of energy, and the temperature of a corresponding body changes; in the first case it rises, in the second case it falls.

The chemical action, the passage from one isomeric condition to the other, is therefore accompanied by an evolution, or by a disappearance of heat, according as the attractions of the atoms are more fully or less fully satisfied in the body in its new condition.

The case is similar in other chemical actions; if the molecules of the substances produced by the reaction contain at the same temperature a smaller total energy than the molecules of the bodies acting upon each other, then the chemical action is accompanied by an evolution of heat; in the opposite case, an absorption of heat takes place. The greater the difference, the greater also will be the change of temperature accompanying the process, so that, if the action takes place rapidly, the temperature may reach that of a red heat, as a result of which the chemical action assumes the character of combustion in the more limited sense of the word.

The aim of quantitative thermo-chemical investigation is now, in the first place, to measure those quantities of heat which are evolved or absorbed in chemical actions. It is true that these values furnish no direct information as to the magnitude of the forces which are concerned in the chemical action, partly because they are merely an expression for the difference between the energy of the molecules decomposed and that of the molecules formed, partly because they are often affected by other actions which accompany the chemical process; they furnish, however, the material for theoretical investigations—for *the higher aim of thermo-chemistry is to establish the dynamical laws of chemical action and to afford an insight into the mysterious region of the constitution of chemical compounds—that is, of the molecules.*

Up to the present time, an almost impenetrable veil has enveloped the internal structure of the molecules and the true nature of the atoms: we know, at the most, the relative number of the different atoms in the molecule, the relative mass of the molecules, and of the individual atoms, and the presence of certain groups of atoms (radicals) in the molecules; but we know almost nothing about the nature of the forces which dominate in the molecule, and which cause the formation and decomposition of compounds.

Experience teaches that the different atoms exert an influence upon each other, which seems to be independent of their mass and which appears now as attraction, now as repulsion, and that the combining capacity of the atoms does not extend beyond a certain limit; still, up to the present time, no satisfactory explanation has been offered for these, the chief phenomena of chemistry. Chemical processes consequently do not as yet admit of a mathematical discussion in their entire extent, as is the case, for example, with the phenomena of physics and astronomy; for the general mathematical discussion of chemical phenomena we lack that which is most important as a basis, namely, a knowledge of the fundamental laws which govern the actions of the atoms. With each decade, however, chemistry approaches nearer and nearer the exact sciences, and already many laws of wider or narrower application are being established on the basis of experiment. The extremely rich and varied material of chemistry now arranges itself in large groups, the members of which follow certain common rules or laws, with reference to their formation and decomposition, and whose properties may be, to a certain extent, deduced from the composition of their molecules.

There is, however, probably no doubt that the mutual action of the atoms, their attractions, and their unequal combining capacity—in short, that "affinity" follows the general dynamic and static laws of mechanical phenomena, and that, in chemistry, as in mechanics, the right of the stronger prevails; with this assumption, general dynamic and static laws may be developed for the phenomena of chemistry, although the real nature of "affinity" is still entirely unknown.

THE HISTORICAL DEVELOPMENT OF MODERN NURSING.*

BY ABRAHAM JACOBI, M. D.

NURSING is as old as the human species. Even among animals, such as they are at present, we find occasional sympathy with fellow-suffering, and meet with efforts for the purpose of relief. We can not imagine that human beings, in ever so remote prehistoric times, should have lived together, or near each other, without mutual attempts at relief, when suffering or sick. But this is presumption only, not history. No book, no tradition refers to facts in regard to the subject until the times of ancient Hellas and its successor in civilization, ancient Rome. Antiquity yields but few proofs of systematic nursing. It is true, hospitality was the pre-eminent virtue of the Greek. The stranger was always welcome. If he was sick, he was doubly so. In all Hellas poor sick citizens found ready admission to and nursing in the houses of the rich. It may be that the facility of finding private relief on the part of the sick was one of the causes why no systematic and collective efforts for the purpose of attending and nursing the sick were ever made to any extent. That such was the case, there can be little doubt; for the temples of Æsculapius and the adjoining residences of the physicians were probably not hospitals, but temporary domiciles for those who congregated in large numbers around the homes of the gods. Of the same nature was the edifice erected by Antoninus Pius near the temple of the Epidaurian Æsculapius. In Italy, also, the temple of Æsculapius, on the island in the Tiber, between Rome and the outlet of the river, was never of much importance as a hospital or sanitarium. The only real hospitals at all comparable with institutions such as we have, existed in favor of human property, and for the benefit of soldiers. According to the testimony of Columella, Seneca, and Celsus, the Romans had hospitals for slaves, warriors, and gladiators. In Greece, also, as early as the period of

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* Address delivered at the first commencement of the Mount Sinai Training-School for Nurses, May 12, 1883.

Solon, those injured on the battle-field were attended and nursed at the expense of the community. Of the great Cæsar it is well known that he had a regular medical service in his armies.

There is a word in the ancient Greek which has given rise to the belief that Hellas may have had hospitals. But, as no facts and reports sustain that supposition, it is probable that *ιατρειον* meant a medical office, a policlinic, perhaps, but not a hospital. Real hospitals were not built by either Greek, Roman, or Hebrew. The commonwealth of the latter was hierarchic and intolerant. The stranger—though he who was permitted to live in Judea was to be treated like a member of the community—was to be exterminated, and must not be spared. Thus, while there are no proofs of the existence of hospitals for the friend, a painstaking care in favor of the stranger was out of the question.

Antiquity, however, is not without its humane culture. The reconciling feature in that immense picture of indifference and thoughtlessness is found in Buddhism. We have the reliable report of a genuine hospital founded by a king in Ceylon, in the fifth century B. C. One of his successors in the second century B. C. is credited with eighteen hospitals under regular medical superintendence. In the East Indies hospitals are mentioned in the third century. Nor have other civilizations been slow in outgrowing the humane exertions of Hellas, Rome, and Palestine, for Prescott tells us that there were hospitals in Mexico before the Christian Spaniards introduced the blessings of torture, inquisition, and extermination. And when finally the Christians, in the second century after Christ, bethought themselves of the poor and sick and established hospitals, the largest and most effective ones were founded in Asia Minor and Persia, where Buddhism had prepared both means and public opinion—Buddhism, under whose beneficent rules aiding the poor and nursing the sick were two of the religious duties of kings and princes. Nor has Christianity the claim of having the first *large* hospitals. The Arabs had many good and large hospitals about 1200. Cordova, in Spain, sustained fifty within its own walls.

The first information in regard to Christian hospitals dates back to the second century; other reports go back as far as the fourth, and a few others to the sixth century. In most cases the establishments were not exactly hospitals, but stopping-places and dormitories for pilgrims on their way to Rome. To what extent such institutions were necessities is best proved by the order of the so-called "Bridge-makers" (*Hospitaliers Pontifes*), whose original vocation it was to protect pilgrims from the robberies and rapacity of the ferry-men on the large rivers. They existed a long time, became rich and degenerated, and were finally dissolved in 1672 by Louis XIV.

The hierarchic character of the institutions calculated to benefit the poor remained intact until the period of the Crusade wars. At that time Italian and German merchants initiated the great combinations of the several orders of Hospital Brothers.

Their efforts were not isolated or altogether premature. For there existed a humanistic movement among the better classes of the Occident, on a Christian basis it is true, but spontaneous. Particularly in the cities, societies were formed for the purpose of nursing the sick and aiding the forlorn. Guy, of Montpellier, France, established a hospital in that city, *of larger size*, while up to that time all the institutions of a similar character were small and unavailing, and located outside the walls. The new hospital in Montpellier, and seven more French houses, and two under the same direction in Rome, are first mentioned in a bull of Pope Innocent III, in the year 1198. The secular character of the institutions was at that time fully recognized. In connecting four clergymen with them he commanded that they were to attend to spiritual duties only ("*sine contradictione et murmuratione*"), and not to interfere with the office of the superiors. In 1204 the same pope recognized the newly established Hospital of the Holy Ghost, on the old Tiber bridge, in Rome. With the peculiar mixture of ferocity and mildness so common to the mediæval age, the same man who humiliated emperors, dethroned kings, and persecuted the French heretics with fire and sword to extermination, looked for the helpless and sick in the streets and saved illegitimate babies from their watery graves. Guy de Montpellier's creation, the Order of the Holy Ghost, did not remain long in its original condition. Pope Gregory X (1271–'76) subjected all the houses belonging to the order to the one located in Rome, the first step in the attempt at depriving the order and its hospitals of their secular supervision. It was finally disposed of by the bull of Pope Sixtus IV, of the 21st of March, 1477. Meanwhile and afterward the order spread over all Europe. With its increasing wealth and power it degenerated in the seventeenth century. Though clerical by name, it was the most secular of all the institutions of dissipation. Grand-master and officers lived on the fat of the land and their immense income. In vain Louis XIV attempted to abolish it. The only change French royalty could work was its transmutation into a royal order. In some of the provinces laymen had succeeded, however, in controlling the management. Thus it was in many parts of Germany, where, between 1400 and 1600, several of the institutions belonging to the order were secularized. In Italy, however, the Order of the Holy Ghost remained exclusively clerical. As late as in the beginning of the eighteenth century it had great possessions in Europe and the West Indies.

The Order of St. Elizabeth was founded in 1225 by Elizabeth, daughter of Andrew II of Hungary, and wife of Landgrave Ludwig of Thuringia. Women need not complain that domestic virtues do not warm more than their own home, and do not immortally challenge the admiration of posterity. Her name will never die, when many a great warrior's memory will be buried out of sight. She founded two hospitals in Eisenach, and another in Marburg, into which the twenty-two-years-old widow retired. The rule was to nurse the female sick only. But when Francis-Joseph and Windischgrätz (*par nobile fratrum*) let loose their Croats over unhappy Vienna, in our own times in 1848, the Sisters of St. Elizabeth were in the front ranks bringing aid and comfort.

In 1171 the orders of St. Protais and St. Gervais were founded in France. About the same time, the houses in Roncesvalles and Burgos. In 1409 José Gilaberto established an order in Valencia for the special purpose of nursing the lunatic.

Those I have mentioned, with several others, were orders founded by the Church, or whose supervision soon became clerical. Those which, though all of them were anxious to submit to the Church, for spiritual reasons, succeeded in retaining their autonomy, must be credited with more real success in accomplishing their ends. Among the first we have any information of is the order of St. Catherine. Its members nursed poor and strange women and girls three days, and buried those who died in prisons or in the streets. In those good old times to which many dissatisfied hearts of to-day look back with longing eyes, those good olden times with their innocence, simplicity, and piety, this dying in the street was of common occurrence, and the Sisters of St. Catherine had plenty of work. We have not only accumulated seven more centuries, but gained more safety, more comfort, and more confidence in the future of mankind.

In the Hôtel-Dieu, the immense Paris hospital, thirty-eight men and thirty-eight women served as nurses. The places were, in later centuries, filled by Sisters of Mercy.

The Brothers of Mercy were founded in 1534 by Juan di Dios (John of God) in Granada. They were laymen, entered the order at between eighteen and thirty-one years of age, and nursed the sick of every faith and creed. Within a hundred years they possessed 18 hospitals, and there was a time when in Spain and the West Indies they had 138 hospitals, with 4,140 beds, and 47,000 sick annually, and in the rest of Europe 155 hospitals, 7,210 beds, and 150,000 sick. Twenty-five years ago they had in Austria alone 29 hospitals, with 20,000 patients.

Of similar character were the Obregons, founded about 1600, with their complicated duties of nursing the sick, praying, and repenting. This multitude of duties must have crippled their efficiency; they can not compare with the Brothers of Mercy.

The "Bons Fils" (Good Boys) were founded in Flanders in 1615. They were tradesmen, with the duties of nursing the sick, mainly the alienated in their homes, and giving elementary instruction.

The Confraternita della Perseveranza was established in Rome, in 1663, for the purpose of caring for the strangers in the taverns.

The Order of the Sisters of Mercy was founded in 1617 by Vincent de Paul, a preacher. In a sermon he placed before his congregation the case of a poor and sick family, urging their co-operation and sympathy. Enthusiasm and much zeal were roused, and a noble and gifted woman, Louise de Marillac, the wife of Legras, the secretary of Mary of Medicis, enlisted herself at once in the service of that family and of many equally indigent. She and her friends worked both in private residences and in hospitals, and were soon recognized as an order. As early as 1636 a house was founded for the care and education of children and women, a foundling hospital was established, and a home for the alienated in 1645. Her order owned, after a single century, 290 stations, and had 1,500 members, who entered between the ages of eighteen and twenty-four, bound themselves for life to the order and the Church, and worked in hospitals and private residences, in the interest of both women and men, in rescuing fallen girls and educating the young. In Rome, mainly in this century, they assisted those taken with infectious and acute diseases who could not be admitted to the public hospitals, and everywhere they attended the chronic cases of sickness of all denominations. Their foothold in Germany dates from this century only. Their greatest adversity was the all-purifying thunder-storm, the French Revolution. Many emigrated to England, but during the Napoleonic wars their services were so much appreciated as to procure for Sister Martha the cross of the Legion of Honor.

All of the orders mentioned were composed of Catholics. Not one of them but was intimately associated with the Church. In this connection it ought not to be forgotten that all the culture and knowledge of the mediæval period was confined within the limits of the Church. Within its fold the whole progress of mankind, slow though it was, toward humanistic evolution, was developed. Thus the efforts of the Catholic Church in favor of the poor and sick must be duly appreciated, the more so, as the so-called "Reformation" party exhibits nothing but blank leaves in the history of ethical and humane development. The revolutionary movement prepared by powerful minds for centuries, and finally carried out by Luther, did not result in any good to the sick and poor for a long time. Indeed, the success of the Reformation was in part due to the greed of German princes, who gained a rich harvest by appropriating monasteries, hospitals, and all other possessions of the Catholic Church. Thus the Lutheran Church, or churches, were left so poor that if they *had* the will they had not the *power* to make any pecuniary sacrifices in the interest of the poor and sick. But *even that will* they had not, could not have. For the first axiom in Luther's doctrine was this, that *not work performed, but faith only*, made the Christian. That doctrine was a long stride backward; it fired the imagination of some bigots, chilled the hearts of most men, sustained the egotist, and created dissensions. Never was there a greater failure. The poetry of the Church gone, its efficiency gone, that was the "reformation." Not until some decades ago did we know of Protestant unions established on the plan of their Catholic predecessors. But the *male* orders never tried to imitate the useful example of the Catholics. *They* did not care for the sick or the poor. *Their aim* was and is "home-mission." *They* are replete with faith, distribute Bibles, and glory in the conversion of that Jew who was baptized, once or often, half a dozen years ago, for ready cash. The women, as always, have done better. Their hospital orders, mainly the Deaconesses, have done good work this half-century, both in public institutions and in private. During the war-times in Germany they and other associations established on similar plans did good work, and deserve all the praise bestowed upon them. Their recognition was complete. Princesses joined hands with them—the Archduchess of Baden, Princess Alice of Darmstadt, the Empress Augusta. And not only in military hospitals did they earn deserved praise. Some general hospitals, such as the Augusta Hospital in Berlin, derive great benefit from their incessant and intelligent labors. I do not mean to stint praise, and therefore make this statement of their work, which has been performed under apparently great difficulties. These difficulties are the very rules, for instance, of the Deaconesses of Kaiserwerth, from which I quote for your edification the following introductory paragraph:

"The Christian women who wish to undertake the office of a nursing sister, as deaconess for the sick and poor, must possess a somewhat advanced Christian knowledge. Mere church-membership, mere attendance on Christian assemblies, and reading of Christian works of edification, are not enough. The love of reading the word of God, and a diligent use of the same for a long time past, must exist, as well as a knowledge of the more important histories of the Old and New Testaments. There must also be a knowledge of the sinful heart from their own personal experience, as well as experience of the grace of Christ, in order that they may have learned to despair of themselves, and in their weakness to trust only to the strength of Christ. A Christian walk of life must for a long time have adorned such Christian women," and so on, and so on. You will admit that in the face of so much hyper-religious sentiment an active, unselfish, modern woman must feel bewildered.

After all I have said, it is evident that the cause of humanity was originally not hampered by the efforts of the Catholic Church. On the contrary, many centuries ago it was the only safe deposit, inasmuch as the Arabs lost their importance in humanistic evolution from the fourteenth century, for the gradual development of human feeling. But that human feeling was not fostered and protected because it was human; the Church had but one purpose, the aggrandizement of the Church. The latter has a meaning in the case of the Catholic Church, which is at least a union, and has a uniform standard, which

Protestantism never had and never can have. The latter has, in its imitation of the ways and words of the mediæval rules of Catholic orders, proved one truth, and I emphasize that because here is the great difference between church nursing and modern nursing. "Clerical care of the sick is destined, under the rules, to serve the Church, whatever that may mean, while serving the sick; the main duties and aims in view are ecclesiastical, and not humane, and, instead of a nurse solely given to the performance of her duties, you deal with ecclesiastical officers" (Virchow). And the necessity is clear, that whatever organization is deemed advisable in the interest of the sick, that organization ought to be in our times *un*ecclesiastical and unsectarian. I have alluded to the fact that whatever medical knowledge existed in the masses centuries ago did so through the medium of the clergy. That knowledge was but trifling, for the ancient medicine of the Greeks and the more recent labors of the Arabs were sealed books at that time. But, then, the clergyman was the doctor. Instead of being so at present, we are daily met with the fact that the exact tendency of modern medicine is an unknown territory to the clergy, and that among them the upholders of all sorts of doubtful practices find their most sincere supporters. Medicine is to them a matter of faith, not science. It is not necessary to refer to that Brooklyn impostor whose criminal carêer has been detailed but lately in the secular press. For no church and no denomination must be held responsible for his methods of fleecing the ignorant and credulous. But the instances where actual clergymen assume responsibilities beyond their clerical powers and duties are also very numerous, and the protection by the Church of a regular monk in a Jersey monastery, who, in the church of his own institution, plies his nefarious trade of laying on hands, and exorcising the devils of disease for cash, these ten years, proves to what extent faith can be abused and the essence of religion distorted. We still live in a time when mediæval ignorance and modern enlightenment appear to find resting-places side by side. That the latter is getting the upper hand, after all, this sketch will prove, I hope, for even the mediæval organizations in the interest of the poor and sick, which I was anxious to estimate at their full value, have finally failed ignominiously. Almost every large society of the kind would degenerate in the end. The uniform report concerning most of them, mainly the male orders, is this, that with increasing power and wealth the original unselfishness of the founder disappeared, the actual work was left to low servants, the wealth of the community was accumulated in the Church. Thus it was that every great calamity sweeping over the lands was a source of riches to the Church. Never was divine blessing more visible in the Church than when half the population of Europe succumbed under the destruction of the "black-death." Never was more business shrewdness developed by "fathers" and "brothers" than when a patient, sick with leprosy—much less contagious than was made out by those who had an interest in exaggerating its dangers—had to give up half his property before being permitted to bury himself for life in the out-of-town places provided by the Church. The omnivorous taste and good digestion of the Church have become proverbial.

The majority of the clerical associations having failed, the seventeenth and still more the eighteenth centuries were far behind former periods in regard to systematic nursing. It has taken a long time between the church institutions, which no longer came up to the intentions of their founders, and the spontaneous efforts of free men and women who felt the necessity of appropriate efforts on a different basis. The history of this slow evolution is very interesting; it is the co-ordinate of the history of a healthy and wholesome individualism in general, after long indifference and chaos.

Schools for training nurses were established in Germany fifty years ago; in Berlin by Dieffenbach, Kluge, and Gedike, and in Göttingen by Ruhstaat. Books to serve the purpose of instructing nurses and the public in general have been written by numerous men and women, some of them, particularly in our days, by celebrities. Gedike himself published a work, fifty years ago, which is a very readable one even now. Passing by Nightingale, who has proved how to become immortal without enjoying high office, or playing on cannon, or tyrannizing nations, or being borne on a throne, let me allude to but a few illustrious names: Nothnagel, who wrote on the nursing of those sick with nerve-diseases; Billroth, who published a book on nursing in general; Esmarch, who taught the first aid in emergencies; and the greatest of the many great men of the century, Virchow, with his many contributions to the literature of the subject, and mainly, in 1869, with a lecture "On the Instruction of Women in caring for the Sick outside the existing Ecclesiastical Organizations."

This instruction of women in caring for the sick, and the relation of women to nursing as a profession, can be considered from two distinct points of view: first, in its influence upon them; second, in its effects upon the public.

The first consideration is a very important one. The opposition to women stepping out of their sphere, which was meant to be cooking and washing, knitting and darning, begging alms and taking a daily whipping, also getting married and raising a family, has been overcome by common sense and habit. Common sense ceased to understand why or how every woman could or should cook and wash, knit and darn, beg alms, or get whipped or married. And habits are formed and reformed with such rapidity that opposition becomes changed into favor in a few years. It is but little more than a dozen years since women physicians were recognized by the profession; not over half a dozen years since you heard of women lawyers. The female part, and, for that matter, the male part of my audience also, are sorry they heard so much of a woman lawyer in a Western town. At all events, the opposition to the attempt at widening woman's sphere, or spheres, has ceased, and the recognition of the principles of equal rights, no matter for what color or sex, or previous servitude, is all but universal.

You will not care to go into the question now, whether law or medicine will ever be resorted to by women to any great extent. The entire liberty given them has proved already, will prove more in future, that neither law nor medicine is an appropriate vocation for any but an exceptional class of women, and that the opposition to women practitioners of law and medicine will come less from the professions than from the public. For the public will never admit that a person in the practice of a profession should not give his or her entire attention and strength to it, and the women of the country will never admit that the superintendence of a home and the proper raising of a family are not sufficient employments of all the time and all the powers of the most gifted woman. The amateurs are losing ground. Thus it is that the professions will never be overrun, and the fear of undue competition has long died out, even among the most chicken-hearted braves of the professions. But the question is not how many women will avail themselves of the opportunities granted, but whether they shall have those opportunities, and whether these shall be given the women of all walks of life, of all standards of intellect. And the question has generally been answered affirmatively, to such an extent that it is considered self-understood that, while the mediæval ages attempted to help them as much as possible, modern times prefer to give them the power to help themselves. In regard to nursing, attention was called early to the unmarried and poor among the women. The statistics of Berlin, of the year 1872, proved that every third woman had to provide for herself. It was remarked with surprise that, of 407 such helpless and breadless creatures, but a single one went into nursing as a business. In other Continental cities it was still worse. In Vienna the shiftlessness of women was still greater; misery and poverty reigned supreme, as must be expected when you learn that a woman who took the making of her own clothing, even *with the aid* of a professional seamstress, into her own hands was punishable under the law.

The proportion of but one nurse to 407 women, who had to work for a living, is remarkable, it is true. For are not nursing, and caring, and attending implanted in woman's nature? What is the reason that so few went into nursing as a business, if not a vocation? Probably, because the women felt, or the public made them feel, that without careful preparation no nurse, or *soi-disant* nurse, can be efficient. We have still the remnants, I fear numerous ones, of that self-made class of nurses among us. In my own recollection of far-away years I remember a great many, and a great many, I was told but lately, remember me also, perhaps too well. Some of you may have seen them—in other people's houses—wrinkled prematurely, thinned out by temper, contrary by nature, or for the most part fattened in the course of their (to them) useful career, complacent, and drowsy while everything was going well, incompetent and snappish when danger required work and sufficiency, always ready to have their regular meals served up-stairs by the help of the house, who breathed freely when they finally left, and always willing to spend their time between rocking a baby, speaking of their long experience, sleeping ten hours, talking gossip all day long, and drinking eleven cups of coffee in the twenty-four hours. This is hardly an exaggeration, for the number of women who took up nursing as a business, driven to it by some natural disposition, gifted with some intellect, modest and willing to profit by superior knowledge and experience, interested in the welfare of their patients, and never stunted in their human feelings by the force of habit, was rather small. But I am glad to say I knew such, too. I gladly shook their hands when I happened to meet them on a common errand, gladly recognizing the diploma they carried in their brains and hearts. But these exceptions proved the rule, and the rule conveyed no blessing. It was, it is, a sad fact that nursing all over the world grew worse in just the same time when medical science grew more exact and medical practice more effective.

Relief in this city came none too soon. The president has detailed to you the history of the training-schools of New York. Since their time the practice in hospitals and in private dwellings has changed wonderfully. After thirty years' work in the city, after twenty-five years' constant labor in public institutions, I ought to know the difference. And I do know and publicly proclaim that the results of the best of physicians have vastly improved since their cases have been in the hands of trained nurses. This is so in private dwellings; it is the same in hospitals. In the hospitals the difference can be measured on a large scale. In them the trained nurse has worked a vast improvement.

Every large hospital ought to perform a double duty. It must give the poor patient, and many rich also, the best possible chance of recovery from sickness. It can afford to accomplish that, because of its pecuniary and intellectual means. Though a hospital be poor, there ought to be, there generally are, means enough to fill all the necessities required. And the intellectual means are expected, are supposed to be, above the average of the general practitioner. There are a great many reasons why that should be so, why hospital places should be open for the competition of the best material among the medical profession, recognized to *be* the best by the medical profession *itself*, and why family and personal influence should not fill places which are better not filled at all than with indifferent or bad material. A hospital must also grant the best possible nursing—attached, wakeful, careful. All this is due to the single patients.

A good deal more, however, is due to the public at large. A hospital looking for the interest of the single patient only might just as well be a private institution, a *maison de santé* for the benefit of a landlord. The benefit derived from hospital treatment by a sick person is not all the satisfaction due to a public who pay four hundred dollars a year for every bed. Nor are the public paid sufficiently for their sacrifices by the accumulated experiences of a few physicians, who enjoy the large field of observation and the opportunity of utilizing it for the benefit of private patients. Every hospital which neglects to increase the stock of medical knowledge, and to give an opportunity of learning the theory and practice of nursing and caring for the sick, performs its duties but half, and serves the public but incompletely. Every large hospital must be, and will be, a clinical school, and a school for nurses. It will be acknowledged that as the presence of a nurse in a sick-ward, who is sent there to learn, is considered unobjectionable, the presence of a few physicians observing a case, which can not be injured by their so doing, is not only not injurious, but ought to be demanded by the public, who have a right to expect a physician in their own families who has seen and knows and understands what he is called in to treat. I do not see why hospital patients only should have the best money and service can afford, and why the public at large should have to fall back in many cases on untried skill. Thus the people have a right to demand that every large hospital should have a clinical school, and a training-school for nurses. The public, who are willing to pay for it, may also demand that the expenses of the same, particularly the nurses' school, should be borne by the hospital. This demand, if considered theoretical only, must stand as long as a hospital is, or claims to be, a public institution. When the board of directors of any institution will recognize that they are not the administrators of the dollars of a small concern, but the benefactors of the public at large, they will also appreciate not only that a few disinterested ladies will open their pocket-books, and collect voluntary contributions, but that a generous public will pay more willingly and more largely.

The demand that a large hospital should be a clinical school and a school for nurses, and that the expense should or might be borne by the institution, is not valid in the case of city or commonwealth hospitals only. Most of the hospitals of the country are originally private institutions. They obtain the character of being public affairs when an always increasing number of men and women become interested in and contributors to them. An institution with one or two thousand paying members represents ten or twenty thousand families —in fact, represents a city. And what it represents, of that it assumes the rights and duties. And the main duty the public at large will soon know how to enforce from the directors of every large hospital is, to administer the public domain to the greatest possible advantage for the greatest possible number. The selfishness of an individual adversary, the animosity of evil-spirited persons will never weigh, ought never to weigh, against the public good; the latter only is the object of those who are placed in trust of money, institutions, and the public welfare, because of their actual or supposed public spiritedness and superior intellect.

Is it necessary to detail the advantages of the services of a trained nurse over those of an untrained one? The latter class, as a rule, brings to their work no previous education, no theoretical schooling, no technical experience. They come mostly from inferior walks of life, with less intellectual power, and less moral force. Only those who come from better stock, and raise themselves to higher ambitions, will spend money, and two years of their lives, for the purpose of learning both theoretically and practically the art of relieving the sick, aiding their comfort, taking responsibilities which sometimes are as difficult as they are life-saving, and obeying orders with intelligence and understanding. That such persons are valuable additions to our hygienic requirements and sanitary progress everybody can conceive. That without them many a case would not recover, in spite of the most competent medical skill, all of you may have experienced. I, for one, know from personal experience that many a case can be, has been saved, first by the medical orders; secondly, and often mostly, by the execution of orders, such an execution as is rendered possible by combined knowledge and skill only. If I say that we practitioners have commenced to feel safe in regard to many of our cases only since we could rely on the co-operation of a trained nurse, I express but a common observation. I trust that there are households within hearing which know how to appreciate the services rendered them by a trained nurse.

So much only in regard to individual cases. But the service to the public at large hitherto rendered, and constantly increasing, is of a different and still more important nature. Who is nowadays the teacher of the public at large in sanitary matters, in hygienic rules? The knowledge of the Church, when *it* nursed, was faith, and, let us add, in its best times, love. The knowledge of uneducated women was, and is, ignorance driven to actual or alleged work by starvation. The knowledge of a trained nurse is the result of a two years' study under competent teachers, and a constant practice. Who in the community is her superior in the knowledge of the facts mostly necessary for the health and life of your children, and dear ones in general? The clergyman is no longer the teacher of the mysteries of life and common sense. The schoolmaster or schoolmistress knows about the classics, geography, and arithmetic, but no normal school ever taught them the elements of applied physiology. The educated member of any profession except the medical has not the slightest idea of the necessities of the body, the action of food, the effect of clothing, and the hundred facts required by different ages, conditions, and states of health. With the exception of the physician, whose advice is frequently sought only to repair the effects of ignorance, the only teacher the public have, and will have, is *the trained nurse.* Ten or twenty families may enjoy her presence annually, ten or twenty mothers will learn simple and important truths, knowledge will increase, and prevention of disease will become a possibility. Enjoyable and useful as the service of a trained nurse is in an individual case of sickness, her services to the community are very much greater, by virtue of her theoretical and practical teaching. May I tell you what a good trained nurse may teach, and can teach? How to recognize a fever, how to compare the local temperatures of the several parts of the body, and how to equalize them; she knows that ever so many feeble children might have been saved, if but the feet and legs had not been allowed to get cold; how to bathe, when, and when to stop; how to regulate the position of the head—I remember quite well the case of inflammatory delirium which would always be relieved by propping up the head—how to treat intelligently an attack of fainting; how to render cow's milk digestible by repeated boiling, or lime-water, or table-salt, or farinaceous admixtures; how to feed in case of diarrhœa; how to refuse food in case of vomiting; how to apply and when to remove cold to the head; how to ventilate a room without draught; and a thousand other things. She will also use her knowledge and influence in weaning the public of nostrums, concerning which hardly anything is known except what you have to pay for the promises of the label. She will break the public of the indiscriminate use of quinia, with its dangers possibly for life; cure you of the tendency of making the diagnosis of malaria the scapegoat of every unfinished or impossible diagnosis; she will teach you that the frequent and reckless domestic use of chlorate of potassium leads to many a case of ailment, to chronic poisoning, possibly in the shape of Bright's disease or to acute poisoning with unavoidable death. These are but very few of the things she can do, and but a little of the knowledge she can not but distribute. With the aid of the class of women who frequent our training-schools, the public at large must and will gain, in a short time. Let the number of the schools increase, and increase the number of pupils, and every one of them will be a teacher and an apostle of sound information on sanitary and hygienic subjects. And let nobody leave this place to-night without intending to aid an institution as helpful as this.

Will the pupils come? Certainly they will. There is an increasing demand for their services. Many times had I to wait a day or two before any of the schools could accommodate me. There is no fear that there ever will be too many good nurses. There is fear, either, that many persons of inferior intelligence and morals will present themselves for or obtain admission to a school. By attending the suffering, it is true, many a crude or brutal nature is ennobled; but I should not advise to run the risk of admitting that class at the expense of the sick, or of a rising and beneficent profession. The occasional specimens of cold-hearted and arrogant persons one is apt to meet, even among trained nurses, must discourage the admission of any but the very best. These *will* apply. The calling is an honorable one, it promises a competence, it corresponds with the innermost nature of woman. It is not true that the Church alone could raise the enthusiasm for hard work, the performance of arduous duties, and self-sacrifice. One of the first nurses I had in my division in Bellevue Hospital, many years ago, was an accomplished girl, the daughter of a rich man in the far West. After a year and a half it took all the influence and begging of her family to take her away from us and her hard work among the poorest of the poor. The large number of ladies, wealthy and accomplished, who work assiduously and regularly under Felix Adler, and in other places, under our very eyes, prove that the very best class of society can be prevailed upon to do the hardest and most beneficent kind of work. And the fact that the *élite* of the women of the city are willing and anxious to undertake the arduous task of founding and supporting training-schools, in the face of all sorts of difficulties, proves also that the work is in accordance with the requirements of both woman's nature and humanity. There will be many trained nurses who will work for humanity's sake, as centuries ago they claimed to serve for God's sake. Many a woman who would have buried herself in a monastery centuries ago, driven from the face of the living earth by misunderstood and unsatisfied longing, I believe, would nowadays become a nurse, knowing and enthusiastic.

Ladies of the graduating class: The remarks I was expected to make have extended into a lecture. You have been used to lectures, however; if you had not enjoyed them, and profited by them, you would not be here to-night, the most honored and most conspicuous of this assembly. Thus I thought I might be permitted to speak, instead of to you, of you, and your chosen calling and its history. From nothing can any profession derive so much advantage as from the history of its development. It is certainly an interesting spectacle to see how your profession depended intimately on the changing conditions of thought and feeling among mankind. You are happy enough to live and work in a time when, while following individual tastes and having individual motives, your labors are given to the suffering for no outside reason, no church command, but from the free choice of free women in the interest of humanity. I had also to allude to several subjects which may to some appear a little outside the legitimate domain of your ambition and duties. You know better. An intelligent woman will not spend two of her young years in acquiring a certain knowledge without enlarging her horizon in general. You have chosen a profession as noble and as deserving as any there is in existence. You will be the interpreters and right hands of the physician, and the connecting link between the physician and not only the single patient, but also the public at large. My opinion of the services you can render is high, but I trust not exaggerated. When your numbers shall increase, and the character of those who are admitted remain of the same standard, your importance will grow. In your hands will, to a great extent, lie the opportunity for removing prejudices, spreading knowledge, healing and preventing disease. Even those of you who will not always consent to serve in *other* people's homes, will, by example and by teaching, remain in close alliance and co-operation with such as intend to remain in the ranks forever. As you now mean to leave us, endowed with the certificate of the required accomplishments, I can only add, while offering my best wishes for your future, that I trust you will never forget the place which gave you so ample opportunities for perfecting yourselves. You will never forget the gentlemen who taught you, nor that accomplished young woman who impressed all of you with the fact that the charms of womanhood will not suffer from hard work, from a classical education, and thorough medical or other knowledge. Do not forget, also, at the beginning of your independent career, the ladies to whose care and sacrifices and labors you owe the existence of the school which sends you forth as its first graduates, nor the great charitable institution which, after having given you your practical training, honors you to-night by the presence of many of its officers, and designates its president to deliver to you your diplomas.

CLOTHING AND THE ATMOSPHERE.

By M. R. RADAU.

CLOTHING is a kind of armor to help us in the battle against the elements, the importance of which increases with the rigor of the climate which man inhabits. The house may be regarded as an amplified clothing, to be used less constantly, but as more enduring than other clothing, and capable besides of furnishing a full shelter. Both clothing and the house have been invented to protect us; but a very common error, which has given rise to many mistakes, has been to regard the house and the clothing as designed essentially to isolate us from the external air. The truth is, that they are simply regulators of our indispensable and constant relations with the ambient atmosphere. These relations can not well be comprehended unless we take account of the complex phenomena by which the temperature of the body is kept up in the midst of the most diverse influences. We know that animal heat is produced by chemical changes that are accomplished in the tissues, and principally, but not exclusively, by the combustion of the food which is assimilated and brought into the circulation, where the inspired oxygen transforms it into alcohol and carbonic acid. This combustion raises the temperature of the blood, and the warm liquid, which penetrates everywhere, warms the organism almost in the same way that a house is heated by hot-water pipes. The activity of respiration and the consumption of oxygen are diminished during sleep, but increased in taking exercise, when a part of the heat produced is transformed into mechanical work; but, from birth to death, man continues, without ever wholly resting, to draw the breath that keeps up the fire of life.

Notwithstanding this incessant production of heat, which may be increased or diminished, according to circumstances, by as much as fifty per cent, the temperature of the body continues almost invariable. In health it is always about 98°, and seldom varies as much as 2°; and yet we know that in some regions of the globe the monthly means of external temperature present variations rising to more than 115°, with much wider divergences in extreme cases. In parts of Siberia the extremes range from 70° or 80° below zero to 80° or 90° above; temperatures of from 120° to 130° have been remarked in hot regions in Australia and Asia; and men have been able to support much higher temperatures than these for a short time—Blagden 259° for seven minutes, and a certain Martinez, by wrapping his head in cloth, 338° for a quarter of an hour. Under such excessive heats, the temperature of the blood may rise a few degrees higher than its ordinary extreme; but such cases are abnormal.

Constancy of bodily temperature is an indispensable condition of health to warm-blooded animals. By what means does Nature supply deficiencies of internal heat and eliminate an injurious excess, and, in either case, restore the organs to the temperature which is most agreeable to the regular performance of the functions of life? The means are various. When food becomes insufficient, calorification is effected at the expense of the tissues of the animal, and it grows lean. When heat is produced in excess, the organism rids itself of it speedily by several outlets. The body may be cooled by radiation, by evaporation, or by conduction or convection. It is estimated that radiation generally carries off half, and the other two ways a quarter each, of the surplus heat. These ratios are, however, far from being constant; they vary with external circumstances. Evaporation is the valve that regulates the loss of heat, by completing, at a given point, the action of conduction and radiation.

The intensity of radiation, by which heat is dissipated from the body around, is proportional to the difference between the normal temperature of the body and that of the surrounding medium, and increases in the neighborhood of a very cold body. We may in this way explain the chilly sensation we feel and which persists in a room that has not been used for a long time, after the fire has been kindled, and even after the air in the room has become quite warm; while, after the room has been well warmed up, we may feel quite comfortable in it, even with the air at a lower temperature than that in which we were previously chilly. In the former case the walls and the furniture were still cold and abstracted so much caloric as to provoke radiation from the body. The loss of heat becomes less and the sensation of cold disappears as soon as the objects around have become tolerably warm. This also explains why it is dangerous in winter to stay long near a wall or a window where one side of the body is exposed to be cooled by excessive radiation.

For a similar reason we feel too hot in a room full of people, even when the air is only moderately warm. The presence of a considerable number of persons prevents radiation, and the excess of heat can be carried off only by currents of air, or by a more abundant transpiration. We fan ourselves to expedite the cooling by convection and evaporation, by bringing more air in contact with the skin; and if we leave the room when we are nearly smothered, to go out "to take a breath" in an empty room, we shall be astonished to find by the thermometer that the temperature of the two rooms is nearly the same; only that radiation is free in the empty one. The agreeable refreshment the shadow of the woods gives us is due to the relatively low temperature produced in the trees by their faculty of evaporation, and the facility it affords for promoting radiation from the skin. The body is also cooled by convection, or by giving off its heat to the air that bathes it, and this loss is more sensible in proportion as the air is cooler and more frequently renewed. The atmosphere is always in motion, even when apparently most calm; and thousands of its movements escape our senses, because they are not strong enough to impress our organs. These ceaseless motions, it must be clear, contribute greatly to the cooling of our bodies; but the effect is most marked in the open air, when we are exposed to the action of the winds. In our climate, the average velocity of the atmospheric currents is about ten feet a second, or seven miles an hour. Supposing that the extent of the surface of the body exposed to the currents is one square metre, there pass over a man walking out for an hour about eleven thousand cubic metres of fresh air. In hot climates we seek the shade, not only because the air under it is fresher, but also because it has more motion, in consequence of the differences in density arising from the unequal heating. Notwithstanding all the devices that have been contrived for the reduction of temperatures, it is evident that civilization is possessed of more varied and efficacious means of contending against the cold than of mitigating the effects of the heat. It is for this reason that the European finds it so difficult to acclimate himself under the tropics. The Hindoo reduces his internal calorification by eating little; but he is at the same time defective in energy, and has extremely little capacity to work. Assiduous labor exacts a large quantity of food, while an excess of surplus heat simultaneously results from it; for the organism can convert into mechanical labor only about twenty-five per cent of the increase of heat which it produces under a sustained effort. The problem we have to solve is not to seek for a way of producing less heat, but to find a means of getting rid of that which we do produce.

Water is a much more effective refrigerant than air, because of its much greater conductibility; at the same temperature, a bath of water will refresh one more than a bath of air; but baths are necessarily of limited use. The important matter should be to diminish the temperature of the air that comes in contact with the body.

We have next to consider the effect of evaporation through the lungs and the skin. When the thermometer indicates more than 98° in the shade, the body can no longer be cooled by contact or by radiation, and only a single way is left by which the surplus heat can be dissipated. It can only expend itself in vaporizing the water which transpiration carries to the skin and to the mucous membrane of the respiratory apparatus. The lungs, as a rule, exhale about half as much water as is excreted by the skin. Both together remove about a kilogramme of water every twenty-four hours, disposing of as much heat as would boil five quarts of water; but the quantity of water and of heat removed in this way may be doubled and even tripled when all the channels of transpiration are fully opened under the pressure of an excess of internal heat. The vapor disengaged by these operations is absorbed by the surrounding air with a facility proportioned to the dryness of the atmosphere, or to the degree in which it is removed from the point of saturation. There is a limit at every degree of temperature to the proportion of vapor which the air can contain; and the interval between the points of dryness and of saturation increases with the temperature. An atmosphere at the same time very moist and very hot seems heavy to us because it hinders the evaporation of the water that transpiration brings to the surface of the body. This is why hot and moist climates are so much more unhealthy than hot and dry ones.

When the internal calorification is increased in consequence of violent exercise, the excess of sensible heat is eliminated by a more intense radiation, by ascending air-currents, and by a more abundant transpiration; it thus happens that after several hours of sustained effort we sometimes observe a slight cooling of the body, an effect which is the result of a too rapid using up of disposable materials. Hence, to cite the illustrations given of this fact by M. Bouchardat, dogs, which have run long at the hunt, and the overworked and exhausted children in the Belgian coal-mines, returning to the lodge or to their home, first of all things, before even satisfying their hunger, stretch themselves before the bright fire for warmth.

Thus the means of refrigeration at the disposal of Nature are quite varied; they complement and replace each other according to circumstances. But it is necessary to avoid the too abrupt changes which would surprise the system while it is in the process of accommodation. "The organization," says Dr. Pettenkofer, "is a prudent and faithful servant, which will deliver itself and its master from trouble if it is given time to set itself right and is protected against rude treatment." The body, even when exposed stark naked to the air, is not wholly without defense against heat and cold. It can, up to a certain point, itself regulate the expenditure of caloric by the intervention of the vaso-motor nerves that go to the capillaries of the skin. Cold provokes a shrinking of the little vessels, and, restraining the peripheric circulation, diminishes the radiation and the transpiration to such a degree as to protect the internal organs for a considerable time. Heat, on the other hand, dilates the vessels so that the blood flows to the surface and the caloric is in a certain way driven out. Unfortunately, this automatic regulator, the play of which is commanded by the nerves, is too easily disordered and its springs are too easily relaxed. We can doubtless fortify it by exercise, harden ourselves, and habituate the body to support inclement conditions ; and there are peoples and persons who have done wonders in this direction ; but the hardening process works under limitations, and its results are not within everybody's reach. The real regulators of the heat of the body are clothes.

The thinnest veil is a vestment in the sense that it moderates the loss of heat which radiation causes the naked body to experience. In the same way a cloudy sky protects the earth against too great cooling in spring nights. In covering ourselves with multiple envelopes of which we augment the protecting thickness according to the rigor of the seasons, we retard the radiation from the body by causing it to pass through a series of stages, or by providing relays. The linen, the ordinary dress, and the cloak constitute for us so many artificial epidermises. The heat that leaves the skin goes to warm these superposed envelopes ; it passes through them the more slowly in proportion as they are poorer conductors ; reaching the surface, it escapes, but without making us feel the chills which direct contact with the atmosphere occasions, for our clothes catch the cold for us. The hairs and the feathers of animals perform the same function as toward their skin, serving to remove the seat of calorific exchange away from the body. The protection we owe to our clothes is made more effectual by their always being wadded with a stratum of warm air. Each one of us thus has his own atmosphere, which goes with him everywhere, and is renewed without being cooled. The animal also finds under its fur an additional protection in the bed of air that fills the spaces between the hairs ; and it is on account of the air they inclose that porous substances, furs, and feathers keep warm.

Experiments to determine the degree of facility with which different substances used for clothing allow heat to escape were made by Count Rumford, Senebier, Boeckmann, James Starck, and M. Coulier.

The results were not in all cases consistent with each other, but they indicate that the property is dependent on the texture of the substance rather than on the kind of material, or—as concerns non-luminous heat—its color.

The most recent experiments are those of Dr. Krieger, some results of which are cited by Dr. Pettenkofer. He observed the rate of cooling of a sheet-iron cylinder filled with hot water and covered by turns with different cloths. Wrapping it with successive envelopes of wool, buckskin, silk, cotton, and linen, and observing regularly the diminution of temperature in a given time, he found the differences insignificant, not exceeding one or two per cent. The color of the materials did not cause the results to vary any more. It appears, then, that in a dark heat the emissive power and the absorbing power, which is correlative with it, vary but little between one kind of cloth and another. The case is different when we have to do with luminous heat, or the solar rays. With envelopes of linen, cotton, flannel, and silk, M. Krieger observed that the absorption of solar heat increased in the proportions indicated by the numbers 90, 100, 102, and 108. The influence of color was much greater: with cotton goods of different hues he found the numbers to be—white, 100; straw-color, 102; yellow, 140; bright green, 155; dark green, 168; Turkey red, 165; bright blue, 198; black, 208. These facts explain why in the hot sun a black coat is warmer than a white one, while the difference disappears in the shade. The influence of colors on the absorbing powers of surfaces had already been made clear by the researches of Leslie and Melloni.

To form an estimate of the part which the conductibility proper of the different materials plays in these phenomena, M. Krieger inquired how much the loss of caloric was diminished when the cylinder was covered with double layers of the same cloths. The doubling of the satin, cotton cloth, and fine linen diminished the loss only by from three to six per cent, while doubling the envelopes of buckskin, flannel, and woolen cloth diminished it by ten, twenty, and even thirty per cent. It is clear from these experiments that the resistance offered by cloths to the passage of heat depends much less on the conductibility of the fibers that form their substance than on the thickness, the volume, and the texture of the tissues. This can also be shown in observing the cooling of a cylinder covered with wadding, which is forty per cent more rapid when the wadding is strongly compressesd. So a dressing-gown lined with wadding and a flannel waistcoat are warmer when we first put them on than after they have been worn for some time. The packing which the filaments undergo with use renders the cloth more permeable to heat. Although doubling the envelope has little influence when both layers are stretched tight over the cylinder, it is not the same when a slight space is left between them; then the cooling is retarded thirty or thirty-five per cent by the interposed stratum of air. Hence, we should expect in many cases to find a loose garment warmer than a tight one; and we know that close-fitting gloves or shoes afford but a poor protection against the cold. This reasoning, however, supposes that the protecting layer of air is motionless; but more frequently an ample and flowing garment favors the circulation of air, and therefore seems to us to be cooler, and is for that reason preferred in summer and in hot climates.

We are now brought to the important fact that the most serious obstacle to the propagation of heat in any body is the discontinuity of its elements. This is because heat is a mode of motion, and every derangement of molecular continuity impedes the transmission of vibrations. This principle is more or less unwittingly put to profitable use in the manufacture of clothing. We obtain very warm clothes from light, loose, and porous tissues, having a capacity to retain in the spaces between their fibers a large volume of air. I said, retain; I might more properly have said, let pass; for the air which our clothes inclose is not motionless, but circulates and undergoes constant renewal in filtering through the envelopes which we mistakenly believe are intended to isolate us from the surrounding medium. It is, in fact, an essential condition of a good garment that it shall not interpose an obstacle to ventilation. The warmest clothes let the air pass more readily than those which are considered cool. Dr. Pettenkofer demonstrated this fact by measuring the volumes of air which under the same pressure and in the same time passed through a series of tubes stopped by pieces of different kinds of cloth. The numbers representing the volumes were for the different goods: flannel, 100; linen, 58; silk, 40; strong cloth, 58; buckskin, 51; glazed skin, 1. Flannel is, then, a hundred times more permeable to the air than a glazed glove, and we know at the same time that it is infinitely warmer. The volumes of air transmitted are but little changed by doubling the goods. Our clothes are thus continually aërated by an exchange, the activity of which depends on the external temperature, the degree to which the atmosphere is agitated, and the porosity of the tissues; the essential point is that the change shall be so slow that the nerves of touch shall not be affected by it. The warmest coat is one of fur, and its warmth lies not in the skin only, but chiefly in the hairs, although their mass is relatively insignificant, and is almost wholly due to the air interposed between them. Furs are warmer in proportion as the hairs are finer, because, doubtless, the air that circulates through them is more thoroughly warmed. There are formed around the bodies of furred animals superimposed strata of air, the temperature of which diminishes from the skin to the ends of the hairs; and in winter the animals seem cold to the touch, while the zone of exchanges retires toward the skin as the cold becomes more intense. The body of the animal is, then, cooled principally by convection and by the ventilation which incessantly removes the heated air. When the atmosphere is much agitated the cold penetrates more readily through the furs, and also through our overcoats, as all know who have been much exposed to cold winds. According to M. Krieger's experiments, the loss of heat through the skin is doubled when the fur is shaved off, and tripled when the skin is varnished. These facts bring us to the conclusion that the goods called impermeable are generally anti-hygienic, because they impede the aëration of the garments beneath them. They are good for protection against rain, but they excite perspiration and prevent its evaporation, and are very uncomfortable in pleasant weather.

Another very important property in cloths is their hygroscopicity; they condense moisture from the atmosphere and become impregnated with it the more speedily as the air is more nearly saturated with vapor, and consequently less capable of favoring evaporation. The condensation, which is equivalent to a kind of dew, is increased when the temperature is diminishing. According to M. Coulier's researches, the water absorbed by a cloth may be divided into two parts: one part which is not perceptible to the touch and can not be pressed out —the hygrometric water proper; and the other part, that which fills the pores and can be wrung out, and which M. Coulier calls interposed water. According to his experiments, wool is more hygroscopic than hempen cloth, and linen than cotton. Dr. Pettenkofer compared the hygroscopic qualities of a piece of linen and a piece of flannel having equal surfaces and nearly equal weights. Having been previously dried at the boiling-point of water, the two pieces of goods were exposed together in places more or less moist, and the variations in weight they went through after several hours of exposure were measured. It was found that wool was nearly twice as hygroscopic as linen. Similar differences between different materials may be observed when they are wet by immersion. Linen gets wet much more speedily than wool, but the wool really absorbs the most water.

The quantity of water that cloths are capable of absorbing is evidently more considerable than is commonly supposed. A woolen coat weighing five or six kilogrammes may take up nearly a litre of water, and this will add a kilogramme to its weight. We see also that cloths absorb more moisture when the temperature is low than at ordinary summer heat. Wet garments conduct heat better than dry ones, and consequently give much less protection against chills; hence the danger of cold combined with dampness. But wool, although it is more hygroscopic than linen, protects better against the effects of humidity because of the slowness with which it absorbs and gives off water, and because of its indestructible porosity.

As we fill up the meshes and pores of a tissue, it becomes less permeable to air, and goods with close meshes, like linen, cottons, and silks, feel this effect much more quickly than woolen goods. As Dr. Pettenkofer remarks, the elasticity of the fibers counts for much in the persistence of porosity. The fibers of wool, even when moistened, lose but little of their elasticity and do not allow the pores to close, while the filaments of linen, cotton, and silk become quite soft under the influence of moisture, and do not resist the invasion of the water. For this reason damp wool cools us much less than damp linen. A linen or silken shirt is cooler than a woolen one, because it more completely sponges off the sweat and exposes it to evaporation. These facts illustrate clearly the capital influence which space between the fibers exercises on the physical properties of cloths. A cloth must evidently be considered as a tissue formed of textile matter and air. The properties of the fibers themselves can give us only the most incomplete ideas of the physical effects which their assemblage would bring about. The arrangement of the fibers and the manner in which they are prepared are most frequently the important points. There is reason to believe that by looking along this road, still so little explored, we shall reach results that will permit us to make a better use of some of the innumerable textile materials which Nature has put at the disposition of our industry.

Hygienists, in speaking of different cloths, are generally contented with classifying them vaguely in the order of conductibility, and of designating by that word the greater or less facility they offer to the passage of heat. It is agreed that conductibility decreases in the following order: linen or hemp cloth, cotton, silk, and wool. Cloths made of linen, hemp, and cotton, are considered the coolest. They are readily moistened and cool the skin by both conductibility and evaporation. Linen, whether made of hemp or flax, is, says M. Bouchardat, of all substances destined for clothing, the one that most favors the affections resulting from the impression of moisture on the skin. But with many persons the coolness and pleasant feeling of linen are very highly appreciated as advantages.

Cotton cloth lets less heat escape, absorbs and retains a part of the perspiration, and cools less rapidly by evaporation; its use is generally more advantageous than that of linen. An opinion or prejudice prevails widely that cotton is less healthful than linen, based on the fact that, being a less perfect conductor and rougher, cotton irritates the skin more than linen does. Examined with the microscope, the fibers of cotton appear angular and stiff, while those of linen are round and supple. Cotton is not agreeable in cutaneous affections, but wool, in such cases being more hairy and warmer, would be still more disagreeable. This is the only condition, says M. Bouchardat, in which any other substance than very fine, well-washed, and well-worn linen can be worse than it. Aside from this, cotton cloth has the advantage over linen of being warmer in winter, and, in summer, of not exposing the body to the dangers of too rapid cooling. It should be used in preference to linen by inhabitants of cold and moist countries. Wool is still more irritating than cotton, on account of the stiffness of the hairs with which it bristles; but the excitation it produces becomes a therapeutic means whenever the skin needs a stimulant. Unfortunately, its use next to the skin may become the source of the infirmities for the cure of which it is indicated when too effeminate an education has caused us to contract the habit of wearing it too early and without sufficient reason. It may cause a grievous predisposition to colds, rheumatisms, and neuralgias, while, the habit once acquired, it can not be given up without danger. But the use of wool is precious in some countries and under some conditions of life.

Professor Brocchi, a writer well known for his investigations in malaria, attributes the good health and vigor of the ancient Romans to their habit of wearing coarse woolen clothes; when they began to disuse them, and to wear lighter goods and silks, they became less vigorous and less able to resist the morbid influence of bad air. It was first at about the time the women began to dress in notably fine tissues that the insalubrity of the Roman air began to be complained of. Dr. Balestra, in his book on the "Hygiene of the City of Rome and of the Campagna," admits that there may be some little truth in these views, although the increasing unhealthfulness of the Roman climate was chiefly explainable by the abandonment of cultivation and the physical degeneracy of the people in consequence of the general change in the manner of living. At any rate, woolen clothing has a right to be considered an excellent prophylactic in countries infected with malaria. "In the English army and navy," says Dr. Balestra, "the soldiers of garrisons in unhealthy places are obliged constantly to wear wool next to the skin, and to cover themselves with sufficient clothing, for protection against paludine fevers, dysentery, cholera, and other diseases." According to Pâtissier, similar measures have been found efficacious to guard the health of workmen employed on dikes, canals, and ditches, in marshy lands; while, previous to the employment of these precautions, mortality from fevers was considerable among them.

The hygienic properties of wool are due, first, to a slight roughness of the surface that excites the functions of the skin; and, secondly, to its porosity, which, as we have already explained, moderates the expenditure of caloric and prevents a too sudden cooling of the body. Dr. Balestra believes that flannel contributes to the elimination from the body of the paludine miasms, which have been absorbed by the pores, and also to rid it of the deposits that cause rheumatic affections. The hypothesis is confirmed by the singular connection that seems to exist in miasmatic regions between rheumatic and intermittent fevers. Furthermore, woolen goods arrest in their down a portion of the germs borne in by the air which thus reaches the skin filtered and purified; Dr. Balestra has proved by direct experiments in marshy regions that thick and hairy woolen garments have the filtering power that is here attributed to them. It is hardly necessary to add that such clothing, to afford real protection, should be frequently washed. Cotton is next to wool in value, and is preferable to linen, because it gives a gentle excitation to the skin. Silk also has a warm feeling, and might be substituted for flannel in the winter; but it could hardly be worn next to the skin in summer, on account of the excessive heat it provokes. Dr. Balestra insists that it is best for inhabitants of unhealthy countries never to go out without being provided with a woolen cloak or blanket, to be used in case the weather should change. The ancient Romans wore ample over-garments over their tunics, and never put them away. It is no less important to be well covered during the night; and precautions of this kind should be recommended to all who live in a swampy country. We are sometimes astonished when we see the natives of particularly warm countries enveloped in woolen, as the Arab in his burnoose, or the Spanish peasant in his tobacco-colored cloak. Such materials protect both against the rays of the sun and against the coolness of the night, and are excellent regulators of heat. It is dangerously imprudent to travel in southern countries without provision of warm clothing.

The hat completes the dress, as the roof crowns the house. It preserves the head from insolation and cold, and protects it against accidents. Without going so far as M. Bouchardat, who says that the best head-dress is none, we content ourselves with remarking that the hat should be light and well aired. According to M. Troupeau's experiments, conical and rounded head-coverings are cooler than flat ones, and preferable in hot countries.

The bed is not only a piece of furniture indispensable to secure repose; it is also, in fact, a dress for the night. Like other articles of clothing, it should be both warm and permeable to the air. The heat which the body gives off to the mattress and the coverings is continually taken away by the air that traverses them. "Beds designed to regulate the flow of heat," says Dr. Pettenkofer, "are with us thicker than the garments which clothe us during the day, for two reasons: first, because, the circulation being less active during rest and sleep, less heat is evolved; and, secondly, because the ascending currents cool us more rapidly in the horizontal than in the vertical position, where they rise from the feet to the head, passing over the whole body." The heat of the bed thus favors the peripheric circulation and assists the internal organs that have to keep up the calorification. To do without a bed for several days in succession is a great privation, not only because it deprives the limbs of rest, but also because of the troubles to the economy it induces. A too hot and too soft bed is also objectionable because it keeps the body in a condition of moisture that enfeebles the muscular system and reduces all the functions. Feather-beds are generally more noxious than useful. They are warm on account of the air they hold; but an air-mattress should be as warm. Birds also clothe themselves in heat when they sleep, by ruffling up their feathers, putting themselves in the shape of a ball, and surrounding themselves with the thick strata of air included within the filaments of their plumage. We purpose in another article to consider the relations of our habitations to the atmosphere.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE SAVINGS OF SCIENCE.*

By P. L. SIMMONDS.

IN the last quarter of a century, very important progress has been made in our home industries and foreign commerce; but certainly the success that has been effected in the utilizing of waste products, and developing neglected ones, is not the least remarkable of recent scientific advances.

It is evident that, when considered from the point of view of industrial science, the phrase, "utilization of waste," may be fairly applied not only to the unused residual products of manufactures, but to the boundless, undeveloped wealth of nature. The beautiful aniline dye, produced from the tar of the gas-works, is not more an example of the utilization of waste than beet-root sugar, obtained from what, a century ago, was a weed growing by the sea-side. Nature produces, abundantly and spontaneously, in many countries, vegetable substances (such, for instance, as the esparto-grass), which were long allowed to run to waste. Important industrial uses have been found for many of them, and fortunes realized by numbers who have turned their attention toward rendering them articles of commerce.

The flesh of domestic animals fit for food is almost a waste substance in many countries, since it can not be locally consumed nor profitably preserved. In the River Plate republics alone there are 80,000,000 sheep and 25,000,000 cattle to a population of 2,500,000. For years sheep were only valued there for their wool, and, when flayed, carcasses were left to rot, or, when dried in the sun, piled up in stacks for fuel, while later on they were boiled down for their tallow. Sheep get very fat in the province of Buenos Ayres, and those of three and four years will give frequently from eighteen to twenty-five pounds of tallow. Countless numbers of sheep are boiled down every year in the so-called *graserías* only for the tallow, which forms one of the staple articles of export. The mutton is thrown away, or used in a dry state as fuel.

In the five years ending with 1850, more than 1,500,000 sheep and 200,000 horned cattle were boiled down simply for their tallow, in the colonies of New South Wales and Victoria.

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* From a paper read before the London Society of Arts.

We English are great meat-eaters, and, as our home supply is quite insufficient, we have to import more than 600,000 tons every year. With the growth of our population, and the decreasing number of live-stock at home, the imports of meat from abroad have prodigiously increased in the last quarter of a century.

In a paper read before the Royal Colonial Institute, Sir Francis Bell, the Agent-General for New Zealand, stated that frozen meat in any quantity can be placed upon this market from the other side of the world at 6*d.* to 6½*d.* a pound, leaving a good profit to the grower. "This," he added, "ought ultimately to make meat cheaper here, or at least prevent the further rise now threatened. Australia and New Zealand can, in fact, export 700,000 tons of meat a year, or 2,000 tons a day, which is not much more than you want in England even now, without reducing even the present capital number of their sheep and cattle, and we are able to send on sheep to Smithfield with greater ease to-day than the Tweed farmers could one hundred years ago, when meat was selling at a penny a pound in Scotland against tenpence in London."

Horses, although numerous in some countries, as in Russia and the River Plate states, have not been, commercially, very useful when dead. In South America mares are never broken to the saddle, and the carcasses are generally boiled down for their fat, the exports of mares' grease being considerable, while the hide is also useful. But, within the period now under our notice, horse-flesh has come largely into use on the Continent for human food. Its sale has become a legalized and recognized trade in many of the Continental states, especially in France and Germany. The published statistics of the Society for Promoting the Use of Horse-flesh show that, since its foundation in July, 1866, 160,080 horses, 6,690 donkeys, and 395 mules had been sold in Paris alone for food, up to the end of 1881, furnishing 67,809,460 pounds of meat. Horse-flesh is sold at half the price of beef. The innovation has gained ground rapidly in most of the principal towns of France, and the public sale of horse-flesh for human food is now general in Austria, Prussia, Bohemia, Saxony, Hanover, Switzerland, Belgium, and Sweden. In England, the hundreds of horses which die in the metropolis are sent, with other carcasses, to special firms, which utilize every part commercially. The skin is removed, and the bones are taken out with great expedition; the flesh is then placed in caldrons, of a capacity of 600 gallons. Upon boiling the flesh, the oil is separated, and used by soap-makers and leather-dressers. The bones are also boiled, yielding further oil and fat, and are afterward utilized for manure.

In the United States there was formerly a plethora of waste. The time was when, in Cincinnati, Chicago, and other slaughtering centers, the food of millions was cast out and allowed to be entirely lost by being thrown into the river, or burned in large pits. Now, such is not the case, for the poor but industrious German and Irish populations have saved much of this extravagant waste, and, by their cheaper labor, almost the whole of these substances has been converted to profitable use. Even now a great deal of the ox is disused, which in Europe is esteemed most nutritious food.

There is an important industry which has sprung up out of animal waste, in the utilization of purified tallow and other fats for food and domestic purposes. It was originated in France in 1869 by M. Mége, and was intended for the manufacture of artificial butter from fat, by extracting the oil at a low temperature, and converting this, by churning, into butter. It was first known as oleomargarine, then as margarine, and latterly as butterine. The manufacture of this product has spread extensively, and it is carried on in the United States on a very large scale. As a London trade journal observed, a few weeks ago, "It is to be regretted that shopkeepers do not see their way to offer it to the public under its proper name, a proceeding which would be not only more honest, but which would ultimately tend to the more general adoption of butterine as an article of daily consumption."

From statistics prepared by Mr. Nimmo, of the United States Department of Agriculture, it appears that more than one third of the American exports of butter are sworn to be oleomargarine. Now, as we receive over 8,700 tons of so-called butter from North America, it is not pleasant to know that one third of this is the artificial butterine. Not only is margarine thus used, but, under the name of sueine, much lard is now introduced into the butter.

In the utilizing of inferior or waste materials, and in the separating of tallow from the substances with which it is found in combination, machines are employed which are both ingenious and effective, and by their use much material that would otherwise be worse than useless is turned to good account.

In Europe, rabbits are not a waste substance, but are eagerly sought for as food, and even bred in large numbers; but their introduction into Australia and New Zealand has proved an unmitigated evil to the colonists. About twenty years ago there was not a single rabbit in Australia, save, perhaps, a few domesticated pets. Since their introduction they have become a perfect pest, and the difficulty is to exterminate and keep them down by poison, dogs, etc.

From New Zealand alone 8,500,000 rabbit-skins were exported in 1880, but this does not probably represent one tenth part of the animals actually destroyed. In that climate the rabbit breeds nearly every month in the year. But even supposing that a pair of rabbits do not breed oftener than in England, which is seven times a year, and that they only bring eight young at a time, they would multiply in the course of four years to 1,250,000. Besides the skins shipped to England and America, the colonists are trying to send us rabbits' flesh in tins. Rabbit-skins are in demand by the furrier. About 30,000,000 indigenous rabbit-skins and 2,000,000 or 3,000,000 hare-skins are used up in this country. The skins of those which are not used or dyed as furs are, after the hair has been pulled for the hat-maker and for stuffing beds, employed for glove-making. The hair is also now used for making yarn and cloth.

The wool manufacture, in almost all countries, now uses up cuttings of cloth and shreds of all kinds which were formerly thrown away. These, and the strippings and waste in carding, are now classed immediately after pure wool, and command relatively high prices. There are many who may be disposed to regard the shoddy manufacture as a business to be despised, but the political economist discovers in it a most important source of wealth—wealth resulting from the application of skilled labor to the utilization of material once worthless, but now contributing no mean sums annually to the wealth of nations.

There are now 137 shoddy-factories, principally situated in the Yorkshire district, which employ over 5,000 persons, 3,000 of whom are females. About 40,000 tons of woolen rags are annually torn into shoddy in England alone, and the quantity made in the United States must be almost equal. No accurate data can be found of the European use of these articles, but an immense quantity of both shoddy and mungo is now made and exported from the Continent, principally to England, and it is probable that the whole of the world's annual consumption is over £7,000,000 in value. At the recent International Wool Exhibition, held at the Crystal Palace under my charge, there were shoddies sent from most of the states of Europe. Italy first began to work woolen rags into yarn in 1858, and most of the other European countries followed the example.

Raw silk having become scarce and dear of late years, much more attention has been given to the employment of the different sorts of silk waste, for which, at one time, scarcely any use could be found.

The variety of these is very large, and most of them are now profitably and extensively employed. The outside and inside husks of the cocoons used to be mere refuse. These pass under various trade names in different countries; in England, as "knubs and husks" and "floss silk"; on the Continent, as *bourre de soie*, *frisonets*, and *floret*. What is termed "yarn waste" is the waste made by the silk throwster. The pierced cocoons, that have been eaten through by the moths, are now largely employed in the preparation of *chappe*, or *schappe*. Then there are the noils and thread waste from the silk-factories.

In 1857 the imports of these waste silks were only 18,000 hundred-weight, valued at £302,286. In 1881 the imports reached 540,119 hundred-weight, valued at £757,796. France, Switzerland, Germany, Great Britain, and the United States have now entered extensively into the utilization of silk waste for manufactures, which was formerly a drug in the market. In the Swiss report on the Paris Exhibition of 1867, it was stated that the annual production of floss-silk yarns then ranged in value from £400,000 to £600,000. In 1872 about 7,750,000 pounds of thread were made from waste silk in Europe. In the United States, 2,000 to 3,000 bales of waste silk are used up annually, valued at £200,000. Italy exports annually about 5,000,000 pounds of silk waste.

There are fifteen establishments in France, with 479,353 spindles, working up waste-silk; that is, the waste from the cocoon not reelable, the short pieces, etc. What remains over from this working is again used up by seven other factories, which, by means of further combing and carding, employ waste formerly only partially utilized or altogether lost to consumption.

In connection with this subject I may draw attention to the stimulus given to the collection of the cocoons of the wild silk-worm of India, known under the name of *Tusser*. These, which were formerly only used in the East for making a kind of drab or coffee-colored silk, have now been made to take dyes, and are profitably employed in the silk manufacture in England. The waste of the wild cocoons in China and Japan is made into felt for hats, and enters into the manufacture of paper.

The improvements in machinery for the preparation and spinning of silk-waste have made great strides of late, and whereas a few years ago one never heard of anything but "spun-silk" hosiery, handkerchiefs, or some other little article of similar make, the whole world now knows the *schappe* velvets of Crefeld, the "spun" ribbons of Basle, and the laces of Nottingham, while the king of silk-spinners—Lister, of Manningham—has even produced machine-twist of excellent quality from this unlikely material.

The refuse from the tanneries, now so profitably utilized, is of considerable importance; it consists of untanned dried pelt, or glue-pieces, fleshings, hair, lime deposit, and spent-tan. Glue-pieces or "scrolls," as they are termed, are sold to the paper-maker, and scores of tons for the manufacture of gelatine and portable soups. Ordinary size is made from the flesh refuse of the hide, and is extensively used by paper-hangers, cotton-spinners (to give firmness to the thread), and carpet manufacturers. The so-called cheap seal-skins are manufactured in the north of England from common plasterers' hair, or that obtained from the tan-pits. There has been made for many years, in Germany, printing-paper and cardboard of the waste bark from tanneries. The common papers receive about ten or fifteen per cent of this pulp; the boards for roofing from twenty to forty per cent. Artificial leather is also now extensively made from leather cuttings, pressed and rolled into sheets with some glutinous composition.

Latterly it has been found that leather-waste cuttings, etc., when steamed with certain waste liquors, produce a valuable material in the shape of a new black, which is destined to have a variety of important uses, such as in the manufacture of printing-inks, dark pigments, covering substances, and notably for the manufacture of blacking. Bone-black, from which the latter is chiefly made, costs £9 per ton, and the supply is limited, while this new tannic black can be sold at one third of the price.

The blood from the slaughter-houses, which used to be wasted, is now collected in Europe, and utilized for manufacturing into blood-albumen, which sells at about 1*s.* a pound. The drainings and the clot go for manure.

Among the miscellaneous animal substances now utilized, we find many species of fish-skin tanned, such as the so-called porpoise-skin, (*Beluga catodon*). Alligators and crocodiles, and even snakes, are hunted for their skins, which are tanned, and provide a valuable article for making slippers, purses, pocket-books, cigar-cases, etc.

Let us now pass to vegetable substances, and I will first consider the paper manufacture. A recent estimate was published, which set down the paper-mills of the world at 4,000, producing 1,000,000 tons of paper, of which one half was used for printing.

It is now evident that the future of the paper industry will, in a large degree, depend upon the use of wood, which is already extensively employed. For the ordinary varieties of paper, ground wood is used; but, for the finer sorts, chemically prepared wood-fiber, or cellulose, is employed. The practical process for the preparation of cellulose was discovered in 1852, and numerous other processes or improvements have since been invented. It comes into commerce in two forms—wood-pulp in sheets or blocks, and ligneous meal or wood flour. In Central Russia, aspen-wood is most extensively employed; in Sweden and Finland, spruce and fir, which afford the longest fibers; in Germany, France, and Belgium, mixed woods. The pulp from beech and birch woods has too short a fiber.

About twenty years ago, some of the American paper manufacturers used the bamboo largely for making paper. This is no new application, for the Chinese have long employed it for a common description of paper. Good paper is now also made from esparto-grass.

A good deal of the jute sent from India to the United States consists of the dark root, or butt-ends of the fiber, which are cut off when the jute is pressed into bales. These are called "cuttings" in Calcutta, and with us, "rejections"; they now form a regularly quoted article of export to America, where they are employed in the fabrication of various shoddy-stuffs. In former years these cuttings were thrown away. Megass, the refuse stalk of the sugar-cane, makes excellent paper. The husks of oats, barley, rye, and rice, are also used alone, or combined with other materials. Straw-board, of late years, has been found to be a cheaper material than the old-fashioned "pasteboard," and it has come extensively into use in America for paper-boxes.

Straw has long been employed as a paper material, but it is often scarce and dear. It is even found profitable to buy up the bedding-litter from the metropolitan stables, and, after washing and disinfecting it, to sell it to the paper-mills.

Until a very recent period, the waste-paper of the Government offices of London was the perquisite of the messengers. But when it was found that the aggregate sales of this waste-paper reached the sum of £10,000 to £15,000 a year, it was thought time to look into this, and it was then handed over to the Stationery-office, and, in the last financial year, the sale of waste-paper reached £11,771. The United States Treasury sells yearly more than 600 tons of paper-pulp, resulting from the destruction by maceration of Government securities, bank-notes, etc.

In one large printing and publishing establishment in London, the waste-paper, in shavings and imperfect impressions, exceeds seventy-five tons a year. Even the newspaper-offices now economize and use up their spoiled impressions, or overplus papers, for printing their posters on.

It is only since 1860 that the extraction of the oil from cotton-seed has been carried on on a commercial scale; before that date vast quantities of the seed were allowed to accumulate and to rot on the cotton-plantations. It is an industrial fact of considerable interest and significance, that at the present time the seed is often more valuable to the planters for its oil and oil-cake than the cotton-fiber, for of the latter it contains only about one quarter of its weight.

In the process of refining, the residue of the crude oil is distilled, and, with care, produces a hard grease or stearine, which commands, when of good color, within 3*s.* or 4*s.* per hundred-weight the price of Petersburg tallow. The by-product is used for making artificial butter. Even the foots, or tarry residue, is useful as a paint ingredient.

It would be difficult to define the limits to which the indirect consumption of Indian corn extends. Every pound of American pork eaten, the laundry and food starches used, the large production of alcohol (that of whisky in the States is 67,000,000 gallons), the varnishes used by the cabinet-maker, the perfumery of the toilet-table, the different kinds of illuminating fluids, all indicate the universality of the employment of maize.

It was in 1867 that a new use was found for maize, by converting it into glucose. The report of the New York Chamber of Commerce states that the production of this sugar is now not less than 1,000 tons a day for the whole United States.

In America, they are also endeavoring to utilize the immense quantities of pulp remaining from the corn after the extraction of the starch. This pulp, which is at present a waste product, consists wholly of cellulose or woody fiber, and would, it is considered, be an excellent material for making the commoner grades of paper, suitable for wrapping and newspaper purposes.

The present sources of the supply of potash are rapidly failing; every year the area of the supply becomes smaller, and the product, in consequence of this and the increased demand, becomes more and more expensive. The cobs of Indian corn, which are now considered of little or no value, may yet share the same fate as many substances which, though formerly considered worthless, have become new mines of wealth, through the aid of chemistry.

The average yield of 1,000 parts of cobs is 7·62 parts of carbonate of potash, or nearly twice as much as the best specimens of wood, and it is a material which can fill its full measure of usefulness for other purposes, before it comes into the hands of the manufacturer of potash. At the shipping ports, large shelling-mills are established, capable of running through 500 bushels of corn an hour. Here, then, are the places where a supply of cobs may be procured.

The corn-crop of North America varies; but, taking the yield of 1871—1,100,000,000 bushels, at fourteen pounds of cobs to the bushel—this would yield 7,700,000 tons of cobs, containing an average of three quarters per cent of pure carbonate of potash. The enormous quantity of 115,500,000 pounds of that useful article might thus be thrown into commerce. In some districts, these corn-cobs are extensively used as fire-lighters, being dipped into a composition of resin and tar, and then dried.

It is only some twenty years now since glycerine, a by-product in the manufacture of soap and candles, has been produced on a commercial scale, but the quantity now made represents an annual value of nearly a quarter of a million sterling. Glycerine has thus attained to a position of considerable technical importance. The introduction of the stearine-candle industry and the efforts to utilize the heretofore waste products of the soap manufacture demonstrated its existence in considerable quantity. The important uses to which this substance is now applied are so numerous that it would be difficult to enumerate them.

There is a large consumption of cork-bark, in this and other countries (the quantity we import exceeds in value half a million sterling), and even in this direction the economizing of the waste is found profitable and useful. The suberine powder is made into cork carpets for floor-cloth, and it is even used by chemists in place of lycopodium, powdered rice, starch, etc. Old corks are collected, and cleaned with hydrochloric acid and hot water, so as to be used again. The Paris sewers are provided with gratings, and the corks thus collected are re-cut, and used again. All cork cuttings are useful for filling life-buoys, belts, jackets, and even beds.

In Europe, as much use has not been made of sea-weed as in China and Japan, where it forms a very large article of consumption for food. In China, it is imported both from Japan and Asiatic Russia, to the extent of more than 25,000 tons a year. It is received in two forms: first quality, cut, and some known as *agar-agar;* and second quality, long. This sea-weed is principally consumed by the lower classes of Chinese as a condiment or flavoring, with their rice or other food.

Another product into which sea-weed is converted is gelose—a sort of vegetable isinglass. Viewed from whatever direction, the more general utilization of sea-weed is a most important matter. In some of the northern countries of Europe, cattle are fed on it. Formerly, iodine was only obtained in any quantity from the kelp of sea-weed, but it now appears likely that it can be produced in Peru at a comparatively small cost, as a by-product extracted during the process of manufacturing nitrate of soda; while the necessary arrangements for the manufacture of iodine from kelp are very costly, and the works and machinery used require a large sum of money. It is possible that 5,000 or 6,000 hundred-weight of iodine might be manufactured in Peru at a low cost, but the war with Chili interfered materially with the production. With the exception of the manufacture of kelp, the principal use of sea-weed is for manuring land. Under the name of carrageen, or Irish moss, some is used for food. In France, a gelatine or gum is prepared from sea-weed, which is variously useful in the arts, as in finishing cotton fabrics, making artificial leather, etc. When chemically prepared and pressed, it was, at one time, used extensively for the manufacture of a substitute for horn, called laminite, but this has been dropped. It has occasionally been made into paper.

There is an application of waste substances of vegetable origin that is largely carried on, which certainly does not merit approval, being, for the most part, prosecuted for the purposes of deception and fraudulent gain, and this is in substitutes for, or additions to, coffee. Figs, date-stones, lupines, malt, chiccory, etc., are largely sold, besides the seeds of a stinking weed (*Cassia occidentalis*) which, when roasted, according to French authorities, is equal to coffee. While the production of coffee is fully equal to the demand, and the price is moderate, I can not see the necessity for these various substitutes. The more legitimate use of date-stones is that to which they are put by the Arabs. They are soaked in water for two or three days, and, when somewhat softened, used to feed their camels, cows, and sheep. There are shops in Medina where they sell only date-stones, and the poor often occupy themselves in collecting the date-stones thrown about the streets by those who eat dates.

Cocoa is not so largely consumed in this country as on the Continent. But the cocoa shells or husks which are separated from the nibs after sifting are imported here to the extent often of 500 tons annually, paying a duty of 2*s.* a hundred-weight, against 9*s.* 4*d.* a hundred-weight charged on cocoa and chocolate. These shells or husks form about twelve per cent of the weight of the beans. In the manufacture of the finer chocolates they are always separated, and hence accumulate in large quantities in France and Spain. In the cheaper kinds of chocolate and cocoa, these husks are ground with the nibs, and some other cheap farinaceous substance is added. The black appearance of such chocolate is unmistakable; it will always be found gritty and rough, and, of course, difficult of digestion. The husks are no better than sawdust, and may cause irritation by the minute spiculæ left after grinding.

I must now touch upon the utilization of mineral waste.

The utilizing of tin-plate cuttings and the recovery of the tin have become important and profitable industries. In the manufacture of tin-ware, it is said six per cent of the whole of the plates employed disappears in the form of scrap. Birmingham produces thirty tons per week. Mr. Beck, of that town, is said to have made a profit for many years of £100 a week by taking off the tin from the scrap by solution and precipitation. A very fair trade is done by parties who go about the tin-works buying up the tin-dust. They even go to France and other countries, and ship it to England to be reduced. This so-called tin-dust is really the scum of the tin-pot, and, as it is mixed with grease, it is black. It contains a considerable quantity of metal, which is reduced by ignition and flux. An engineering paper states that the waste of tinned iron, used for all kinds of purposes, but especially for saucepans, kettles, button-making, etc., was formerly large, but a method is now employed by which the tin can be recovered from the waste, simply by the action of dilute sulphuric acid. Tin, to the extent of from five to fifteen per cent, and worth about £97 per ton, with a vast amount of sulphate of iron, is thus procured, giving a large profit on the operation.

Within the last quarter of a century, that formerly neglected mineral—pyrites—has been turned to useful purposes, to supply our manufacturers with the important material, sulphur.

In wire-making factories, the dilute sulphuric acid, formerly used to clean the wire, was allowed to run into the sewer, when it had become so charged with the iron scale as to cease to "bite," and large quantities of refuse wire were employed only to fill up hollows in grading, or thrown into a heap. All this waste material is now, however, converted into articles of commercial value. The processes are simple and comparatively inexpensive.

Not only in the inferior metals is waste now prevented, but increased attention is given to the collection of gold formerly lost. Immense heaps of refuse, or "tailings," as they are technically termed, accumulate where mining operations are carried on. The sludge which is emptied from the puddling-mills in Australia contains a considerable quantity of fine gold. Much of this is now recovered, and the yield of gold from it exceeds three pennyweights per ton. The right to wash the tailings is often sold to the Chinese, who are always well satisfied with the result of their labors.

The quantity of gold used in the arts, in interior and exterior decorations, in photography, electro-gilding, water-gilding, the ornamentation of china, etc., is very large, and the greater part is practically lost. Jewelers' sweepings from the floors of the workshops are carefully collected, and even the clothes of the workmen are generally saved and sent to the refiner. After a large gold coinage at the Royal Mint, there is always a great deficiency in waste and sweep. The sweep is composed of cinders or dust from the forge, the sweepings of the workshops, broken crucibles, the dross which adheres to the ingots of metal after fusion, and of every waste which can possibly contain minute particles of the metal. This is generally sold. The silver and gold from photographers' waste is also now carefully collected, and forms a considerable item of economy. A method of utilizing the waste of gold-leaf, used in printing and the arts, is by converting it into what is called fleece-gold. The composition is used like the ordinary bronze, except that rather more copal is mixed with it. It is used for all fancy papers for which gold-leaf and bronze have hitherto been used.

The waste of the glass-furnaces—such as pieces of broken glass, flaw-glass, the hearth-droppings, and the glass remaining adherent to the blower's pipe—is utilized again, serving a purpose in the manufacture of glass, similar to rags in paper-making. Agate glass is made by melting waste pieces of colored glass. One to two thousand tons of cullet, or broken glass, are collected in the metropolis alone, and sold to the few city glass-works to be remelted. Broken bottles are now collected and utilized. Thousands of tons of these are broken every year in London alone. Broken "wines" and broken "sodas" are converted to many useful purposes, the latter especially. The broken bottles are utilized for the manufacture of cheap jewelry, chimney-ornaments, and inferior household glass for the manufacturing districts. They are also used for the manufacture of emery-powder, glass paper, etc. Some idea of the number of "sodas" broken in the process of filling, corking, cleaning, and distributing may be gathered from the circumstance that one great mineral-water manufacturer in London sold last year one hundred tons. The value of the "metal," as it is styled, is somewhere about ten shillings per ton, but it varies according to the demand. When the market for "fancy goods" is active, broken bottles command a better price. A revival of trade sets this particular industry in motion along with others, and broken bottles are enhanced in value. In fact, broken glass and broken pottery serve many purposes, though it is only lately that economic science has learned how to turn them to account.

The utilization of blast-furnace slag is not new, but has made great progress. Scattered throughout the iron-making districts of Great Britain are many million tons of scoria or refuse from the blast-furnaces, which is technically known as "slag." This slag goes on accumulating at the rate of nearly 8,000,000 tons per annum, its bulk being some three times that of the iron from which it has been separated. It forms a heavy incumbrance to iron-masters, demanding the purchase of large tracts of land whereupon to deposit it, while the investment is, of course, wholly unremunerative. There are one or two exceptions to this rule, where the slag is tipped into the sea, and serves to form land for the works, and where some of the iron-works supply slag for the construction of breakwater and training walls. The quantity thus utilized, however, on the Tees is but about 600,000 tons per annum, forming only a small proportion of the whole yield of the district.

In early times, slag was broken up by hand, and used for road-making, and it so continues to be used, where it can be had without a heavy cost for transport; but there is only a limited demand for this purpose. On the Continent, where stone is scarce, slag plays a prominent part in road-making, as in Silesia and other similarly situated districts. Another direction in which many attempts have been made to utilize slag, both at home and abroad, is to adapt it for constructive purposes, and various schemes have been devised for transforming the highly refractory slag into bricks, sand, and other materials for building.

It is also applied to the manufacture of artificial stone, and molded into chimney-pieces, window-heads, balustrading, and outside ornamental builders' work generally. The stone is composed of two and a half parts of finely pulverized slag, and two and a half parts of ground brick, to one part of Portland cement. The mixture is run into molds, and sets quickly, the articles being ready for the market in four or five days. Besides bricks and stone articles, the slag is used for making mortar, cement, and concrete. The mortar is a mixture of slag and common lime, the cement being composed of the same materials, with the addition of iron oxides.

Another useful purpose for which it has been successfully utilized is that of glass manufacture. The vitreous character of slag indicates a resemblance to glass in its composition. It does, in fact, contain the principal components of glass, but not in proper proportions, and those in which it is deficient have therefore to be added, with others which are not present. Bottles made of this slag by the Britten Patent Glass Company were shown at the Paris Exhibition in 1878, and received honorable mention.

Another application is to the manufacture of slag-wool. By the action of strong jets of steam, the slag is transformed into a fibrous whitish silicate cotton, which, being metallic, is incombustible, like asbestos. In the construction of new houses with Mansard-roofs, the space between the interior lath, or paneling, and the exterior covering of zinc, slate, or tin, is filled with this slag-wool, which protects from the rigor of frost in winter and the intense heat in summer. If in winter the taps and spouts and water-pipes are covered with this slag-wool, it prevents the freezing of the water and the bursting of the pipes and joints. This slag-wool is also used now by gardeners to cover plants and protect them from the effects of sudden changes of temperature.

In view of the general usefulness of slag, when converted into the various articles described, it is to be hoped, in the interests of commerce and progress, that the practice of its utilization may become more and more extended. Doubtless, human progress will show that what is now the veriest waste will, in the course of time, assume a condition of value. Thus will art be made to approximate to nature, in that it will know no waste.

There are one or two other mineral substances, formerly neglected, which have of late years been applied to very extensive important uses. One of these is asbestos. This was long considered a mere curiosity for making small fire-proof articles. It is the only flexible fibrous mineral substance that is perfectly indestructible by fire or acids, notwithstanding it consists of fibers as fine as the finest linen. Now it is scarcely possible to enumerate all the uses to which it is applied. Among others are, as a roofing material, cement, paint, fire-proof coating for inside of factories, theatres, etc., in danger of ignition, felting for steam-pipes, boilers, lining for floors, roofs, etc.

A prominent and peculiar feature in the landscape of the coal-mining regions is the enormous heaps of black and apparently useless material collected near the outlet of each mine. As the quantity of small waste coal in the United Kingdom has been estimated at 28,000,000 tons per annum, the utilization of this refuse is a matter of national importance in more senses than one. It is now, in many districts, consolidated into blocks, and, besides what is used at home, 412,310 tons of this patent manufactured fuel were exported last year.

In several foreign countries, the pitch from coal-tar is combined with coal-dust, and pressed into the form of bricks, and an excellent fuel is thus produced, which, it is said, will generate a greater amount of heat than can be obtained from the same quantity of any other combustible material employed for utility or comfort, while, at the same time, it can be stored more compactly and in better shape than either wood or coal. Some 40,000,000 tons of valueless coal-dust, lying in the vicinity of the coal-mines and depots of Pennsylvania, have been thus gradually utilized. In some American factories they have found it cheaper and more advantageous to burn only coal-dust or pea-coal. A furnace or grate bar has been specially devised for the purpose of burning this kind of fuel, and there is no doubt, with its increasing uses, but that other convenient devices will be supplied for making it of more practical benefit. The utilization of this waste in the coal-regions of the United States is now a decided success. The American Fuel Company, Pennsylvania, works up large quantities of culm (as the coal-dust is technically called) with pitch into blocks, brick-shaped, weighing but fourteen pounds each. Anything tending to the utilization of what is now waste is of value, when we consider that the amount of anthracite coal sent to market represents but about four fifths of the quantity that is actually raised from the earth, the balance being piled up in unsightly heaps.

Many of the subjects which I have incidentally touched upon have been so elaborately dealt with by specialists in papers before the members of this society, that the ground has been taken from under me, and I am but a gatherer and gleaner, summarizing, as it were, the results of their descriptions. Although, in the period under review, many of the waste products of manufactures, formerly thrown away, have been made to serve a useful purpose, there is yet room for fresh efforts in this direction, and the reward is certain. The manufacturer who discovers a heretofore unknown use for the waste product of his work necessarily cheapens the cost of the principal article of his production, and thus secures an advantage over competitors. Much, as we have seen, has already been done in this way, but there are many other products which could be made under the direction of that mighty converter, chemistry, to yield substances of use and profit.

Science has taught us how to transmute the waste and refuse materials—elements of pollution—into sources of economy and wealth. The utilization of the sewage of great cities for agricultural ends has virtually been a demonstrated success in Paris and many of our own towns. The same success, by patient experiment, is obtainable in many other waste products, which, in ignorance of their value, we suffer to defile our streets, pollute our rivers, and taint the air we breathe. The purification of the outflow of paper-mills and the utilization of the sludge and other waste products are now carried out.

It would have been impossible, in the limits of this paper, to refer in detail to more than a few of the principal examples of the successful use of refuse. But those enumerated will serve to show to how great an extent civilization is daily adding to the useful products of the world, both by economizing its resources and by calling forth new ones with the aid of chemistry.

SYMBIOSIS AND "VEGETATING ANIMALS."

A REVIEW.

By W. T. SEDGWICK, Ph. D.,
ASSOCIATE IN BIOLOGY, JOHNS HOPKINS UNIVERSITY, BALTIMORE.

SINCE the publication of the interesting observations and speculations of Dr. Karl Brandt concerning the occurrence of chlorophyl in animals, of which a summary account was given in a recent number of this periodical, under the heading "A Partnership of Plant and Animal Life," at least two important contributions to the same subject have made their appearance. One of these, written by Mr. P. Geddes, of Edinburgh, may be found in "Nature" of January 26, 1882. The other, from the pen of Professor E. Ray Lankester, was published in the April number of the "Quarterly Journal of Microscopical Science."

The spectroscopic examination of animal pigments, a line of investigation in which Professor Lankester was one of the earliest observers, has shed much light on these previously little known compounds, and has opened a wide field for further research. Especially fruitful in this direction was the announcement, perhaps a dozen years ago, that various animal greens yield a spectrum identical or nearly so with that furnished by chlorophyl, the common green coloring-matter of plants. At once a host of interesting questions sprang up as to the occurrence, structure, and properties of "animal chlorophyl"—all of which, however, culminated in this: Is the color "accidental" and unimportant in animals, or has it rather some profound significance, such as attaches to it when it is found in vegetable protoplasm?

It may well be considered as one of the fundamental truths of biology that chlorophyl in vegetable substance is no insignificant intruder. Though the exact method of its working is just now a matter of much dispute, the broad fact of its usefulness is freely admitted; in one way or in another, chlorophyl aids in the economy of the vegetable cell so that it feeds greedily upon the carbonic acid of the surrounding air or water, and tears to pieces, for building up afresh its own substance, compounds which, without chlorophyl, it would be powerless to utilize, or which if utilized would be speedily sacrificed. A long series of experiments, reaching from the time of Priestley to the present day, uphold and strengthen this fundamental fact; but, among them all, the simplest is the most unique and the most pronounced. If a piece of a green plant be immersed in water and exposed to sunlight, bubbles of oxygen are given off, and analysis will prove that carbonic acid has simultaneously disappeared from the water. With plants not green, or with animals, the facts are reversed—oxygen disappears and is replaced by carbonic acid.

The green plants, then, exhibit a peculiar power, viz., that of splitting up carbonic acid, and of availing themselves for the manufacture of starch, etc., of the carbon thus gained; at the same time procuring such a large supply of oxygen that they are able to reject a vast amount over and above their own needs. In this respect they differ from colorless plants and animals, and for this power they depend exclusively upon the agency of chlorophyl. We have no evidence whatever that the chlorophyl of plants has ordinarily any other function.

Very considerable interest has consequently been felt in the solution of the question, What significance (if any) has chlorophyl when found in animals? And since the only known use to which it could in general be put (inferring from plants) is in decomposing carbonic acid, and thus aiding alimentation, it has become an important question to discover if this same physiological habit belongs to animal chlorophyl. If it can be proved that animal substance endowed with chlorophyl can, just as well as plant protoplasm similarly colored, break down carbonic acid and utilize its elements, then we remove the last formidable barrier between plant and animal protoplasm. If it should be shown, on the other hand, that when found in animals it is always functionally incapable of splitting up carbonic acid, it is true that we preserve a point of difference between plants and animals, but a result so negative would land us in a new difficulty, viz., that of explaining its presence by attributing to it some other function, and one unknown to plant chlorophyl. No sufficient explanation of this kind has hitherto been offered. In some cases a "protective resemblance" to vegetation would explain its occurrence; but in most cases this is out of the question.

Now, up to 1878 no evidence of value had ever been advanced to show that animal chlorophyl does enable its host to split up carbonic acid and give off the excess of oxygen resulting. In that year, however, Mr. Geddes, whose later work is referred to above, visited Roscoff and found there quantities of "the grass-green planarian (worm) *Convoluta Schultzii*, of which multitudes are to be found in certain localities on the coast, lying on the sand covered only by an inch or two of water, and apparently basking in the sun. It was only necessary to expose a quantity of these animals to direct sunlight to observe the rapid evolution of bubbles of gas, which, when collected and analyzed, yielded from forty-five to fifty-five per cent of oxygen."

Having obtained so much of valuable evidence, Mr. Geddes followed up his discovery by examining these green worms to see whether or not the animal protoplasm derives the same kind of benefit from its work as does plant protoplasm which is known, as a result of the co-operation of chlorophyl, to build up starch or starchy compounds.

This, indeed, proved to be the case, for he adds: "Both chemical and histological observations showed the abundant presence of starch in the green cells; and thus these planarians, and presumably also *Hydra*, *Spongilla*, etc., were proved to be truly 'vegetating animals.'"

The only link here needed is the full proof that the "grass-green planarian" owed his color to veritable chlorophyl. There is little or no reason to doubt it; yet, when we are told by Professor Lankester that in *Spongilla* alone among animals has spectroscopic investigation really *proved* the presence of that pigment, we can not help wishing that this confirmatory evidence had been obtained by Mr. Geddes.

Meantime slow progress had been making in a kindred subject. Before speaking of this, however, it must be said that chlorophyl is now known to be by no means a simple substance, but is rather made up of several simpler compounds not well understood. Nor is it always green, though in that form it occurs most familiarly. Sometimes the true chlorophyl is obscured by some other color, and is nevertheless perfectly functional, physiologically speaking; for instance, a yellow color is particularly common in the lower forms of plants—as in the algæ.

In 1871 Cienkowski boldly announced his conviction that certain yellow cells, which, first pointed out by Huxley, had for some time attracted attention in the substance of radiolarians, were really no part of the animals themselves, but rather veritable algæ living in the animals. Haeckel had previously called them "liver-cells," and when starch was found in them he believed his view confirmed, as it is in the liver of the higher animals that glycogen—a form of starch—is constantly present. The views of Cienkowski made little progress, however, till 1879, when a distinguished morphologist, R. Hertwig, of Jena, who had previously taken sides with Haeckel, adduced reasons which inclined him to the belief that the yellow cells were "parasitic," as Cienkowski had considered them to be.

In the same year (1879) the brothers Hertwig concluded that the so-called pigment-bodies in the tentacles of certain sea-anemones are true algæ—plants, multiplying by tranverse division. Then followed quickly the paper by Dr. Brandt, referred to at the beginning of this review. His work was extensive, and resulted in a complete confirmation of the observations of Cienkowski and the Hertwigs. He fully believes that the yellow cells are true algæ, and was able to prove his points to his own satisfaction. He went, however, a step further, and announced his conviction that all animal chlorophyl is to be considered as located in associated vegetable organisms, which, together with the animal, make up "a partnership of plant and animal life." He unhesitatingly puts *Hydra viridis* and *Spongilla* (green variety) in this position, and thus disposes of all "vegetating animals," or animals living like plants endowed with chlorophyl.

In October, 1881, Mr. Geddes visited Naples for the sake of making further studies upon this subject, and in the paper in "Nature," referred to above (and which has been freely drawn upon in preparing this review), he gives a summary account of his work.

He devoted his attention at first to the yellow cells of *Radiolaria*, and was completely successful in demonstrating in them not only a cell-wall of cellulose and contents made up of protoplasm and nucleus, but he was also able to watch their growth both before and after the death of the animal; and, what was of special interest, he obtained a fair amount of evidence that certain tiny bubbles which in sunlight studded the radiolarians were really made up, in part at any rate, of oxygen. Besides this, he pronounces starch to be invariably present, and completely confirms the observations of Cienkowski and Brandt as to the survival and growth of the yellow cells long after the animal has perished. The yellow pigment, he says, is identical with that of diatoms, and gives the same chemical reactions.

Turning his attention next to the sea-anemones, medusæ, etc., he was equally successful. He is convinced that the pigment-bodies are true algæ; and he records this remarkable experiment: "The exposure of a shoal of the beautiful blue pelagic Siphonophore, *Velella*, for a few hours, enabled me to collect a large quantity of gas which yielded from twenty-four to twenty-five per cent of oxygen. . . . But the most startling result was obtained by the exposure of the common *Anthea cereus* [sea-anemone], which yielded great quantities of gas, containing on an average from thirty-two to thirty-eight per cent of oxygen." He was able also to prove that this gas came from the associated algæ—specimens destitute of algæ giving off no oxygen whatever.

It is, therefore, now very certain that the yellow cells of radiolarians and the pigment-bodies of cœlenterates are in many cases true algæ living in the animal substance. Geddes's work, when added to that of Cienkowski, the Hertwigs, and Brandt, makes this so clear that we are justified in fully accepting their theory, and in hereafter considering the association of certain chlorophyl-bearing plants with certain animals as an established fact. It has been proposed to apply to this association the term *symbiosis*, and to designate animals which are thus supplied with algoid messmates as "symbiotic." So much for the "yellow cells" and pigment-bodies of radiolarians and cœlenterates. Dr. Brandt, it will be remembered, has expressed his belief that the green-colored *Hydra* and *Spongilla* are also symbiotic. In Mr. Geddes's paper nothing is said upon this subject, although, from a remark let fall near the close, it is plain that when the paper was written he did not accept Dr. Brandt's view, but would reserve *Hydra*, *Spongilla*, and *Convoluta*, for a special group of "vegetating animals" distinctly unlike those which are symbiotic.

Professor Lankester, however, while inclined to accept all that has been shown for symbiosis in the other cases, refuses most emphatically to apply that doctrine to *Hydra* and *Spongilla*. His dissent is all the more important, because he has paid much attention to the study of animal and plant pigments (especially with the spectroscope); and, because he was the first to establish the presence of chlorophyl in *Hydra* and *Spongilla*, he has a special right to be heard in this case. In the paper quoted above he attacks the subject with great vigor, and describes several important experiments tending to show that the green color of *Hydra* and *Spongilla* is due to chlorophyl bodies analogous rather to those structures in plants than to any algoid messmates. He fails to confirm Dr. Brandt's observations, and questions the virtue of his inferences so generally, that the two authorities are practically in diametrical opposition. It is obvious that still further studies must be made upon these so-called "vegetating animals," and that at present it would be highly unsafe to consider them as symbiotic.

Professor Lankester's paper is full of entertaining facts of his own discovery, but a number of experiments made by Mr. Blomfield, of Oxford, and University College, London, and quoted by Professor Lankester, are of special interest to us in this connection, as they furnish some evidence that the green *Hydra* does, like *Convoluta*, evolve oxygen in the sunlight. The observations are incomplete, but nevertheless of much value as they go to establish a second case in which animals destitute of yellow cells and pigment-bodies, but endowed presumably with true chlorophyl, do actually give off oxygen.

Meantime the reader can not have failed to perceive that the question as to the evolution of oxygen has become of secondary importance. It is nothing strange if algæ living in animals give off oxygen by virtue of their chlorophyl. In any special case we must now first inquire—Are the colored parts mere plants dwelling within the animal, or are they not? If not, then we must, if possible, apply the spectroscope for the study of the pigment (the chlorophyl group giving rather characteristic spectra), and then, if chlorophyl is present, test, if we can, for oxygen elimination. It is tolerably clear that the occurrence of native chlorophyl in animal protoplasm is not so wide-spread as was suspected before symbiosis was detected; yet the cases of *Hydra*, *Spongilla*, and *Convoluta* are still unsettled, and others may be added to their number: it must be granted, however, that the indications seem to be that in some cases animals may possess veritable chlorophyl arranged as in plants, giving the same spectrum and having the same power over carbonic acid.

At present it will be far more profitable to consider the significance of symbiosis than to speculate upon the result of observations belonging to the future. Professor Semper, in his work entitled "Animal Life," reminds us that, if it should come to pass [as it has] that we must consider much of the chlorophyl found in animals to be borne by vegetable messmates, we need not be surprised; since lichens—formerly supposed to be simple vegetables—have now been shown to be associated organisms—a fungus parasitic upon algæ. There is, indeed, much superficial resemblance between the two phenomena, and it is said to have been from the literature of lichens that the expressive word, *symbiosis*, was borrowed. In truth, there is really less analogy than at first appears; and, as there is no reason for considering the lichens as other than interesting and complicated cases of parasitism, we may hereafter, I think, reserve the word *symbiosis* for the description of that very different association of algæ with animals which it has been the purpose of the writer to elucidate. The word *zoöphyte* might, indeed, be used here with an accurate meaning had it not already a very definite (though utterly senseless) use in pseudo-scientific books and minds.

Mr. Geddes pictures at considerable length the probable physiological relationship between the organisms associated in symbiosis;

and in what comes hereafter we must to a great extent follow his lead. The algæ which are found in animal substance have been referred to above as "parasitic," but it is chiefly to avoid the use of this term that the more accurate one (symbiosis) has been employed. A closer analogy than that offered by the lichens would be, it seems to me, afforded by any perfect plant—an oak, for example. Here the colorless cells—of the root, let us say—are bound to live at the expense of the green cells in the stem and leaves. Yet we do not think of this as a parasitic event. The root-cell is rather a unit in a vast colony of units (cells) associated for mutual benefit. The green cell gets quite as much good from the root-cell as the latter gets from the green cell; water and salts are exchanged by the root-cells for sugary matters and other things readily made use of by any cell, and no harm (as would be the case in parasitism), but rather much good, is done by the exchange. Evidently the oxygen thrown off by the alga is precisely what the plant needs, and the carbonic acid and nitrogenous waste eliminated by the animal is most useful to the alga. Moreover, the algæ gain the advantage of ready locomotion with their host, and the animal can go further into unfavorable media when stocked with algæ ready to build up starches and sugary matters from carbonic acid and water. If either dies, the other is the gainer; since the algæ can thrive on the products of animal decomposition, and algæ—digestible, i. e., dead algæ—are much esteemed by most animals.

The whole burden of the physiological history of symbiosis is forcibly summed up by Mr. Geddes as follows: "Thus, then, for a vegetable cell no more ideal existence can be imagined than that within the body of an animal cell of sufficient vital activity to manure it with carbonic acid and nitrogen waste, yet of sufficient transparency to allow the free entrance of the necessary light. And, conversely, for an animal cell there can be no more ideal existence than to contain a vegetable cell, constantly removing its waste products, supplying it with oxygen and starch, and being digestible after death. . . . In short, we have here the relation of the animal and the vegetable world reduced to the simplest and closest conceivable form.

"It must be by this time sufficiently obvious that this remarkable association of plant and animal is by no means to be termed a case of parasitism. If so, the animals so infested would be weakened, whereas their exceptional success in the struggle for existence is evident. *Anthea cereus*, which contains most algæ, probably far outnumbers all the other species of sea-anemones put together, and the radiolarians, which contain yellow cells, are far more abundant than those which are destitute of them. . . . Such an association is far more complex than that of the fungus and alga in the lichen, and indeed stands unique in physiology as the highest development, not of parasitism, but of the reciprocity between the animal and vegetable kingdoms."

The foregoing paper was written several months ago, and since that time important contributions to the subject have been made by Geddes, Hamann, Jickeli, Entz, and especially by Brandt. The latter has published a summary of the whole matter, enriching it by observations of his own made at the zoölogical station at Naples. Brandt attaches less physiological significance to symbiosis than does Geddes, from whom he still differs in considering even *Hydra* and *Spongilla* as symbiotic and not "vegetating" animals. At present the views of Brandt, as laid down in his last paper (see "Mitt. aus zool. Stat. Neapel," iv, ii, 1883), seem likely to prevail; and in that article the student will find a complete literature and a full discussion of the whole subject.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XIII.

THE process of frying follows next in natural order to those of roasting and grilling. A little reflection will show that in frying the heat is not communicated to the food by radiation from a heated surface at some distance, but by direct contact with the heating medium, which is the hot fat commonly, but erroneously, described as "boiling fat."

As these papers are intended for intelligent readers who desire to understand the philosophy of the common processes of cookery, so far as they are understandable, this fallacy concerning boiling fat should be pushed aside at once.

Generally speaking, ordinary animal fats are not boilable under the pressure of our atmosphere (one of the constituent fatty acids of butter, butyric acid, is an exception; it boils at 314° Fahr.). Before their boiling-point, i. e., the temperature at which they pass completely into the state of vapor, is reached, their constituents are more or less dissociated or separated by the repulsive agency of the heat, new compounds being in many cases formed by recombinations of their elements.

When water is heated to 212° it is converted completely into a gas, which gas returns to the fluid state without any loss on cooling below 212°. In like manner if we raise an essential-oil, such as turpentine, to 320°, or oil of peppermint to 340°, or orange-peel oil to 345°, or patchouli to 489°, and other such oils to various other temperatures, they pass into a state of vapor, and these vapors, when cooled, recondense into their original form of liquid oil without alteration. Hence they are called "volatile oils," while the greasy oils which can not thus be distilled (in which animal fats are included) are called "fixed oils."

A very simple practical means of distinguishing these is the following: Make a spot of the oil to be tested on clean blotting-paper. Heat this by holding it above a spirit-lamp flame, or by toasting before a fire. If the oil is volatile, the spot disappears; if fixed, it remains as a spot of grease until the heat is raised high enough to char the paper, of which charring (a result of the dissociation above-named) the oil partakes.

But the practical cook may say, "This is wrong, for the fat in my frying-pan does boil, I see it boil, and I hear it boil." The reply to this is, that the lard, or dripping, or butter that you put into your frying-pan is oil mixed with water, and that it is not the oil but the water that you see boiling. To prove this, take some fresh lard, as usually supplied, and heat it in any convenient vessel, raising the temperature gradually. Presently, it will begin to splutter. If you try it with a thermometer you will find that this spluttering-point agrees with the boiling-point of water, and if you use a retort you may condense and collect the splutter-matter, and prove it to be water. So long as the spluttering continues, the temperature of the melted fat, i. e., the oil, remains about the same, the water-vapor carrying away the heat. When all the water is driven off, the liquid becomes quiescent, in spite of its temperature, rising from 212° to near 400°, then a smoky vapor comes off and the oil becomes darker; this vapor is not vapor of lard, but vapor of separated and recombined constituents of the lard, which is now suffering dissociation, the volatile products passing off while the non-volatile carbon (i. e., lard-charcoal) remains behind, coloring the liquid. If the heating be continued, a residuum of this carbon, in the form of soft coke or charcoal, will be all that remains in the heated vessel.

We may now understand what happens when something humid—say a sole—is put into a frying-pan which contains fat heated above 212°. Water, when suddenly heated above its boiling-point, is a powerful explosive, and may be very dangerous, simply because it expands to 1,728 times its original bulk when converted into steam. Steam-engine boilers and the boilers of kitchen-stoves sometimes explode simply by becoming red-hot while dry, and then receiving a little water which suddenly expands to steam.

The noise and spluttering that are started immediately the sole is immersed in the hot fat, are due to the explosions of a multitude of small bubbles formed by the confinement of the suddenly expanding steam in the viscous fat, from which it releases itself with a certain degree of violence. It is evident that, to effect this amount of eruptive violence, the temperature must be considerably above the boiling-point of the exploding water. If it were only just at the boiling-point, the water would boil quietly.

As we all know, the flavor and appearance of a boiled sole or mackerel are decidedly different from those of a fried sole or mackerel, and it is easy to understand that the different results of these cooking processes are to some extent due to the difference of temperature to which the fish is subjected.

The surface of the fried fish, like that of the roasted or grilled meat, is "browned." What is the nature, the chemistry of this browning?

I have endeavored to find some answer to this question, that I might quote with authority, but no technological or purely chemical work within my reach supplies such answer. Rumford refers to it as essential to roasting, and provides for it in the manner already described, but he goes no further into the philosophy of it than admitting its flavoring effect.

I must therefore struggle with the problem in my own way as I best can. Has the gentle reader ever attempted the manufacture of "hard-bake," or "toffy," or "butter-scotch," by mixing sugar with butter, fusing the mixture, and heating further until the well-known hard, brown confection is produced? I venture to call this fried sugar. If heated simply without the butter it may be called baked sugar. The scientific name for this baked sugar is *caramel.*

The chemical changes that take place in the browning of sugar have been more systematically studied than those which occur in the constituents of flesh when browned in the course of ordinary cookery. Believing them to be nearly analogous, I will state, as briefly as possible, the leading facts concerning the sugar.

Ordinary sugar is crystalline, i. e., when it passes from the liquid to the solid state it assumes regular geometrical forms. If the solidification takes place undisturbed and slowly, the geometric crystals are large, as in sugar-candy; if the water is rapidly evaporated with agitation, the crystals are small, and the whole mass is a granular aggregation of crystals, such as we see in loaf-sugar. If this crystalline sugar be heated to about 320° it fuses, and without any change of chemical composition undergoes some sort of internal physical alteration that makes it cohere in a different fashion. (The learned name for this is *allotropism*, and the substance is said to be *allotropic*, other conditioned; or *dimorphic*, two-shaped.) Instead of being crystalline the sugar now becomes vitreous, it solidifies as a transparent amber-colored glass-like substance, the well-known barley-sugar, which differs from crystalline sugar, not only in this respect, but has a much lower melting-point; it liquefies between 190° and 212°, while loaf-sugar does not fuse below 320°. Left to itself, vitreous sugar returns gradually to its original condition, loses transparency, and breaks up into small crystals. In doing this, it gives out the heat which during its vitreous condition had been doing the work of breaking up its crystalline structure, and therefore was not manifested as temperature.

This return to the crystalline condition is retarded by adding vinegar or mucilaginous matter to the heated sugar, hence the confectioners' name of "barley-sugar," which, in one of its old-fashioned forms, was prepared by boiling down ordinary sugar in a decoction of pearl barley.

The French cooks and confectioners carry on the heating of sugar through various stages bearing different technical names, one of the most remarkable of which is a splendid crimson variety, largely used in fancy sweetmeats, and containing no foreign coloring-matter, as commonly supposed. Though nothing is added, something is taken away, and this is some of the chemically-combined water of the original sugar, in the parting with which not only a change of color occurs, but also a modification of flavor, as anybody may prove by experiment.

When the temperature is gradually raised to 420°, the sugar loses two equivalents of water, and becomes *caramel*—a dark-brown substance, no longer sweet, but having a new flavor of its own. It further differs from sugar by being incapable of fermentation. Its analogies to the crust of bread and the "brown" of cooked animal food will be further discussed in my next.

XIV.

In my last I described the dissociation of sugar by heat and the formation of caramel, to illustrate by simple example the "browning" of other kinds of food. I might have added, in connection with this cookery of sugar, an historical connection with one of the lost arts of the kitchen—viz., the "spinning" of sugar. Within the reach of my own recollection no evening party could pretend to be stylish unless the supper-table was decorated with a specimen of this art—a temple, a pagoda, or something of the sort done in barley-sugar. These were made by raising the sugar to 320°, when it fused and became amorphous, or vitreous, as already described. The cook then dipped a skewer into it, the melted vitreous sugar adhered to this and was drawn out as a thread, which speedily solidified by cooling. While in the act of solidification it was woven into the desired form, and the skillful artist did this with wonderful rapidity. I once witnessed with childish delight the spinning of a great work of art by a French cook in St. James's Palace. It was a ship in full sail, the sails of edible wafer, the hull a basket-work of spun sugar, the masts of massive sugar-sticks, and the rigging of delicate threads of the same. As nearly as I can remember, the whole was completed in about an hour.

But to return from high art to chemical science. The conversion of sugar into caramel is, as already stated, attended with a change of flavor: a kind of bitterness replaces the sweetness. This peculiar flavor, judiciously used, is a powerful adjunct to cookery, and one which is shamefully neglected in our ordinary English domestic kitchens. To test this, go to one of those Swiss restaurants originally instituted in this country by that enterprising Ticinese, the late Carlo Gatti, and which are now so numerous in London and our other large towns; call for *macaroni al sugo;* notice the rich, brown gravy, the "sugo." Many an English cook would use half a pound of gravy-beef to produce the like, but the basis of this is half an ounce of sugar, or even less; the sugar is browned by heating, not quite up to the caramel state. Burnt onion may contribute, but this is only another form of caramel with more savory properties.

While engaged upon your macaroni, look around at the other dishes served to other customers. Instead of the pale slices of meat spread out in a little puddle of pale, watery liquid, that are served in English restaurants of corresponding class, you will see dainty morsels, covered with rich, brown gravy, or surrounded by vegetables immersed in the same. This sugo is greatly varied according to the requirements, by additions of stock-broth, tarragon-vinegar, ketchup, etc., etc., but burnt sugar, or burnt onions, or burnt something is the basis of it all, sugar being the cheapest.

To further test the flavoring properties of browning, take some eels cut up as usual for stewing; divide into two portions; stew one brutally—by this I mean simply in a little water—serving them with this water as a pale gravy or juice. Let the second portion be well fried, fully browned, then stewed, and served with brown gravy. Compare the result. Make a corresponding experiment with a beef-steak. Cut it in two portions: stew one brutally in plain water; fry the other, then stew it and serve brown.

Take a highly-baked loaf, better one that is black outside; scrape off the film or crust that is quite black, i. e., completely carbonized, and you will come to a rich brown layer, especially if you operate upon the bottom crust. Slice off a thin shaving of this, and eat it critically. Mark its high flavor as compared with the comparatively insipid crumb of the same loaf, and note especially the resemblance between this flavor and that of the caramel from sugar, and that of the browned eels and browned steak. A delicate way of detecting the flavor due to the browning of bread is to make two bowls of bread and milk in the same manner, one with the crust, the other with the crumb of the same loaf. I am not suggesting these as examples of better or worse flavor, but as evidence of the fact that much flavor of some sort is generated. It may be out of place, as I think it is, in the bread and milk, or it may be added with much advantage to other things, as it is by the cook who manipulates caramel and its analogues skillfully.

The largest constituent of bread is starch. Excluding water, it constitutes about three fourths of the weight of good wheaten flour. Starch differs but little from sugar in composition. It is easily converted into sugar by simply heating it with a little sulphuric acid, and by other means of which I shall have to speak more fully hereafter when I come to the cookery of vegetables. When simply heated, it is converted into dextrin or "British gum," largely used as a substitute for gum-arabic. If the heat is continued a change of color takes place; it grows darker and darker until it blackens just as sugar does, the final result being nearly the same. Water is driven off in both cases, but in carbonizing sugar we start with more water, sugar being starch plus water or the elements of water. Thus the brown material of bread-crust or toast is nearly identical with caramel.

I have often amused myself by watching what occurs when toast-and-water is prepared, and I recommend my readers to repeat the observation. Toast a small piece of bread to blackness, and then float it on water in a glass vessel. Leave the water at rest, and direct your attention to the under side of the floating toast. Little thread-like streams of brown liquid will be seen descending in the water. This is a solution of the substance which, if I mistake not, is a sort of caramel, and which ultimately tinges all the water.

Some years ago I commenced a course of experiments with this substance, but did not complete them. In case I should never do so, I will here communicate the results attained. I found that this starch caramel is a disinfectant, and that sugar caramel also has some disinfecting properties. I am not prepared to say that it is powerful enough to disinfect sewage, though at the time I had a narrow escape from the Great-Seal Office, where I thought of patenting it for this purpose as a non-poisonous disinfectant that may be poured into rivers in any quantity without danger. Though it may not be powerful enough for this, it has an appreciable effect on water slightly tainted with decomposing organic matter.

This is a very curious fact. We do not know who invented toast-and-water, nor, so far as I can learn, has any theory of its use been expounded, yet there is extant a vague, popular impression that the toast has some sort of wholesome effect on the water. I suspect that this must have been originally based on experience, probably on the experience of our forefathers or foremothers living in country places where stagnant water was a common beverage, and various devices were adopted to render it potable.

Gelatine, fibrine, albumen, etc.—i. e., all the materials of animal food—as already shown, are composed, like starch and sugar, of carbon, hydrogen, and oxygen, with, in the case of these animal substances, the addition of nitrogen; but this does not prevent their partial carbonization (or "caramelizing," if I may invent a name to express the action which stops short of blackening). Animal fat is a hydrocarbon which may be similarly browned, and, if I am right in my generalization of all these browning processes, an important practical conclusion follows, viz., that cheap soluble caramel made by skillfully heating common sugar, is really, as well as apparently, as valuable an element in gravies, etc., as the far more expensive coloring-matter of brown meat-gravies, and that our English cooks should use it far more liberally than they usually do.

Its preparation is easy enough; the sugar should be gradually heated till it assumes a rich brown color and has lost its original sweetness. If carried just far enough, and not too far, the result is easily soluble in hot water, and the solution may be kept for a long time, as it is by cooks who understand its merits. In connection with the idea of its disinfecting action, I may refer to the cookery of tainted meat or "high" game. A hare that is repulsively advanced when raw, may by much roasting and browning become quite wholesome, and such is commonly the case in the ordinary cooking of hares. If it were boiled or merely stewed (without preliminary browning) in this condition, it would be quite disgusting to ordinary palates.

A leg of mutton for roasting should be hung until it begins to become odorous; for boiling it should be as fresh as possible. This should be especially remembered now that we have so much frozen meat imported from the antipodes. When duly thawed it is in splendid condition for roasting, but is not usually so satisfactory when boiled. I may here mention incidentally that such meat is sometimes unjustly condemned on account of its displaying a raw center when cooked. This arises from imperfect thawing. The heat required to thaw a given weight of ice and bring it up to 60°, is about the same as demanded for the cookery of an equal quantity of meat, and therefore, while the thawed portions of the meat is being cooked, the frozen portion is but just thawed, and remains quite raw.

A much longer time is demanded for thawing—i. e., supplying 142° of latent heat—than might be supposed. To ascertain whether the thawing is completed, drive an iron skewer through the thickest part of the joint. If there is a core of ice within, it will be distinctly felt by its resistance.

XV.

Before leaving the subject of caramel, I should say a few words about French coffee, or "coffee as in France," of which we hear so much. There are two secrets upon which depend the excellence of our neighbors in the production of this beverage: First, economy in using the water; second, flavoring with caramel. As regards the first, it appears that English housewives have been demoralized by the habitual use of tea, and apply to the infusion of coffee the popular formula for that of tea, "a spoonful for each person and one for the pot."

The French after-dinner coffee-cup has about one third of the liquid capacity of a full-sized English breakfast-cup, but the quantity of solid coffee supplied to each cupful is more than equal to that ordinarily allowed for the larger English measure of water.

Besides this, the coffee is commonly though not universally flavored with a specially and skillfully prepared caramel, instead of the chiccory so largely used in England. Much of the so-called "French coffee" now sold by our grocers in tins is caramel flavored with coffee, rather than coffee flavored with caramel; and many shrewd English housewives have discovered that, by mixing the cheapest of these French coffees with an equal quantity of pure coffee, they obtain a better result than with the common domestic mixture of three parts coffee and one of chiccory.

A few months ago a sample of "coffee-finings" was sent to me for chemical examination, that I might certify to its composition and wholesomeness. I described it in my report as "a caramel, with a peculiarly rich aroma and flavor, evidently due to the vegetable juices or extractive matter naturally united with the saccharine substance from which it is prepared." I had no definite information of the exact nature of this saccharine substance, but have good reason to assume that it was a by-product of sugar-refining.

Neither the juice of the beet-root nor the sap of the sugar-cane consists entirely of pure sugar dissolved in pure water. They both contain other constituents common to vegetable juices, and some peculiar to themselves. These mucilaginous matters, when roughly separated, carry down with them some sugar, and form a sort of coarse sweet-wort, capable, by skillful treatment, of producing a rich caramel such as I received.

I tested its practical merits by making an infusion of pure coffee of fine quality, dividing this into two parts, adding to one a small quantity of the caramel, and leaving the other half unmixed. I found the infusion greatly improved in flavor by the admixture, and recognized the peculiarity which characterizes the coffee prepared by Gatti and his compatriots, whose numerous establishments are doing so much for the promotion of temperance in this country. The aroma of this particular caramel is peculiarly fine, and the greater part of it is soluble in boiling water; thus I was able to mix it by merely adding to the coffee as we add sugar.

I have used my best eloquence in trying to persuade the manufacturers to sell it separately, but have not yet succeeded. They seem to have had painful experience of the gastronomic bigotry of Englishmen, who refuse to eat or drink anything that is not hallowed by the sanction of their great-grandmothers, unless it is surreptitiously introduced by means of some device approaching as nearly as possible to a commercial swindle.

Returning to the subject of frying, we encounter a good illustration of the practical importance of sound theory. A great deal of fish and other kinds of food are badly and wastefully cooked in consequence of the prevalence of a false theory of frying. It is evident that many domestic cooks (not hotel or restaurant cooks) have a vague idea that the metal plate forming the bottom of the frying-pan should directly convey the heat of the fire to the fried substance, and that the bit of butter or lard or dripping put into the pan is used to prevent the fish from sticking to it, or to add to the richness of the fish by smearing its surface.

The theory which I have suggested (see No. XIII, page 818) is that the melted fat cooks by convection of heat, just as water does in the so-called boiling of meat. If that is correct, it is evident that the fish, etc., should be completely immersed in a bath of melted fat or oil, and that the turning over demanded by the greased-plate theory is unnecessary. Well-educated cooks understand this distinctly, and use a deeper vessel than our common frying-pan, charge this with a quantity of fat sufficient to cover the fish, which is simply laid upon a wire support, or frying-basket, and left in the hot fat until the browning of its surface, or of the flour or bread-crumbs with which it is coated, indicates the sufficiency of the cookery.

At first sight this appears extravagant, as compared with the practice of greasing the bottom of the pan with a little dab of fat; but any housewife who will apply to the frying of sprats, herrings, etc., the method of quantitative inductive research, described and advocated by Lord Bacon in his "Novum Organum Scientarum," may prove the contrary.

"Must I read the 'Novum Organum,' and buy another dictionary, in order to translate all this?" she may exclaim in despair. "No!" is my reply. This Baconian inductive method, to which we are indebted for all the triumphs of modern science, is nothing more nor less than the systematic and orderly application of common sense and definite measurement to practical questions. In this case it may be applied simply by frying a weighed quantity of any particular kind of fish—say sprats—in a weighed quantity of fat used as a bath; then weighing the fat that remains and subtracting the latter weight from the first, to determine the quantity consumed. If the frying be properly performed, and this quantity compared with that which is consumed by the method of merely greasing the pan-bottom, the bath-frying will be proved to be the more economical as well as the more efficient method.

The reason of this is simply that much or all of the fat is burned and wasted when only a thin film is spread on the bottom of the pan, while no such waste occurs when the bath of fat is properly used. The temperature at which the dissociation of fat *commences* is below that required for delicately browning the surface of the fish itself, or of the flour or bread-crumbs, and therefore no fat is burned away from the bath, as it is by the overheated portions of a merely greased frying-pan; and, as regards the quantity adhering to the fish itself, this may be reduced to a minimum by withdrawing it from the bath when *the whole* is uniformly at the maximum cooking temperature, and allowing the fluid fat to drain off at once. When cooked on the greased plate, one side is necessarily cooling, and the fat settling down into the fish, while the other is being heated from below.

SOME UNSOLVED PROBLEMS IN GEOLOGY.*

By Dr. J. W. DAWSON.

I.

MY predecessor in office remarked, in the opening of his address, that two courses are open to the retiring president of this Association in preparing the annual presidential discourse—he may either take up some topic relating to his own specialty, or he may deal with various or general matters relating to science and its progress. A geologist, however, is not necessarily tied up to one or the other alternative. His subject covers the whole history of the earth in time. At the beginning it allies itself with astronomy and physics and celestial chemistry. At the end it runs into human history, and is mixed up with archæology and anthropology. Throughout its whole course it has to deal with questions of meteorology, geography, and biology. In short, there is no department of physical or biological science with which geology is not allied, or at least on which the geologist may not presume to trespass. When, therefore, I announce as my subject on the present occasion some of the unsolved problems of this universal science, you need not be surprised if I should be somewhat discursive.

Perhaps I shall begin at the utmost limits of my subject by remarking that in matters of natural and physical science we are met at the outset with the scarcely solved question as to our own place in the nature which we study, and the bearing of this on the difficulties we encounter. The organism of man is decidedly a part of nature. We place ourselves, in this aspect, in the sub-kingdom vertebrata, and class mammalia, and recognize the fact that man is the terminal link in a chain of being, extending throughout geological time. But the organism is not all of man; and, when we regard man as a scientific animal, we raise a new question. If the human mind is a part of nature, then it is subject to natural law; and nature includes mind as well as matter. On the other hand, without being absolute idealists, we may hold that mind is more potent than matter, and nearer to the real essence of things. Our science is in any case necessarily dualistic, being the product of the reaction of mind on nature, and must be largely subjective and anthropomorphic. Hence, no doubt, arise much of the controversy of science and much of the unsolved difficulty.

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* Address of the President of the American Association for the Advancement of Science, delivered at Minneapolis, August 15, 1883. Reprinted from "Science."

We recognize this when we divide science into that which is experimental, or depends on apparatus, and that which is observational and classificatory—distinctions, these, which relate not so much to the objects of science as to our methods of pursuing them. This view also opens up to us the thought that the domain of science is practically boundless; for who can set limits to the action of mind on the universe, or of the universe on mind? It follows that science must be limited on all sides by unsolved mysteries; and it will not serve any good purpose to meet these with clever guesses. If we so treat the enigmas of the sphinx Nature, we shall surely be devoured. Nor, on the other hand, must we collapse into absolute despair, and resign ourselves to the confession of inevitable ignorance. It becomes us, rather, boldly to confront the unsolved questions of Nature, and to wrestle with their difficulties till we master such as we can, and cheerfully leave those we can not overcome to be grappled with by our successors.

Fortunately, as a geologist, I do not need to invite your attention to those transcendental questions which relate to the ultimate constitution of matter, the nature of the ethereal medium filling space, the absolute difference or identity of chemical elements, the cause of gravitation, the conservation and dissipation of energy, the nature of life, or the primary origin of bioplasmic matter. I may take the much more humble *rôle* of an inquirer into the unsolved or partially solved problems which meet us in considering that short and imperfect record which geology studies in the rocky layers of the earth's crust, and which leads no further back than to the time when a solid rind had already formed on the earth and was already covered with an ocean. This record of geology covers but a small part of the history of the earth and of the system to which it belongs, nor does it enter at all into the more recondite problems involved; still it forms, I believe, some necessary preparation, at least, to the comprehension of these.

What do we know of the oldest and most primitive rocks? At this moment the question may be answered in many and discordant ways; yet the leading elements of the answer may be given very simply. The oldest rock formation known to geologists is the lower Laurentian, the fundamental gneiss, the Lewisian formation of Scotland, the Ottawa gneiss of Canada. This formation of enormous thickness corresponds to what the older geologists called the fundamental granite—a name not to be scouted, for gneiss is only a stratified granite. Perhaps the main fact in relation to this old rock is that it is a gneiss; that is, a rock at once bedded and crystalline, and having for its dominant ingredient the mineral orthoclase—a compound of silica, alumina, and potash—in which are imbedded, as in a paste, grains and crystals of quartz and hornblende. We know very well, from its texture and composition, that it can not be a product of mere heat; and, being a bedded rock, we infer that it was laid down layer by layer, in the manner of aqueous deposits. On the other hand, its chemical composition is quite different from that of the muds, sands, and gravels usually deposited from water. Their special characters are caused by the fact that they have resulted from the slow decay of rocks like these gneisses, under the operation of carbonic acid and water, whereby the alkaline matter and the more soluble part of the silica have been washed away, leaving a residue mainly silicious and aluminous. Such more modern rocks tell of dry land subjected to atmospheric decay and rain-wash. If they have any direct relation to the old gneisses, they are their grandchildren, not their parents. On the contrary, the oldest gneisses show no pebbles, or sand, or limestone—nothing to indicate that there was then any land undergoing atmospheric waste, or shores with sand and gravel. For all that we know to the contrary, these old gneisses may have been deposited in a shoreless sea, holding in solution or suspension merely what it could derive from a submerged crust recently cooled from a state of fusion, still thin, and exuding here and there through its fissures heated waters and volcanic products.

It is scarcely necessary to say that I have no confidence in the supposition of unlike composition of the earth's mass on different sides, on which Dana has partly based his theory of the origin of continents. The most probable conception seems to be that of Lyell; namely, a molten mass, uniform except in so far as denser material might exist toward its center, and a crust at first approximately even and homogeneous, and subsequently thrown into great bendings upward and downward. This question has recently been ably discussed by Mr. Crosby in the London "Geological Magazine." *

In short, the fundamental gneiss of the lower Laurentian may have been the first rock ever formed; and in any case it is a rock formed under conditions which have not since recurred, except locally. It constitutes the first and best example of these chemico-physical, aqueous or aqueo-igneous rocks, so characteristic of the earliest period of the earth's history. Viewed in this way, the lower Laurentian gneiss is probably the oldest kind of rock we shall ever know—the limit to our backward progress, beyond which there remains nothing to the geologist except physical hypotheses respecting a cooling, incandescent globe. For the chemical conditions of these primitive rocks, and what is known as to their probable origin, I must refer you to my friend Dr. Sterry Hunt, to whom we owe so much of what is known of the older crystalline rocks,† as well as of their literature and the questions which they raise. My purpose here is to sketch the remarkable difference which we meet as we ascend into the middle and upper Laurentian.

In the next succeeding formation, the true lower Laurentian of Logan, the Grenville series of Canada, we meet with a great and sig-

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* June, 1883.

† Hunt, "Essays on Chemical Geology."

nificant change. It is true we have still a predominance of gneisses which may have been formed in the same manner with those below them; but we find these now associated with great beds of limestone and dolomite, which must have been formed by the separation of calcium and magnesium carbonates from the sea-water, either by chemical precipitation or by the agency of living beings. We have also quartzite, quartzose gneisses, and even pebble-beds, which inform us of sand-banks and shores. Nay, more, we have beds containing graphite which must be the residue of plants, and iron-ores which tell of the deoxidation of iron oxide by organic matters. In short, here we have evidence of new factors in world-building—of land and ocean, of atmospheric decay of rocks, of deoxidizing processes carried on by vegetable life on the land and in the waters, of limestone-building in the sea. To afford material for such rocks, the old Ottawa gneiss must have been lifted up into continents and mountain-masses. Under the slow but sure action of the carbonic dioxide dissolved in rain-water, its feldspar had crumbled down in the course of ages. Its potash, soda, lime, magnesia, and part of its silica, had been washed into the sea, there to enter into new combinations and to form new deposits. The crumbling residue of fine clay and sand had been also washed down into the borders of the ocean, and had been there deposited in beds.* Thus the earth had entered into a new phase, which continues onward through the geological ages; and I place in your hands one key for unlocking the mystery of the world when I affirm that this great change took place, this new era was inaugurated, in the midst of the Laurentian period.

Was not this time a fit period for the first appearance of life? Should we not expect it to appear, independently of the evidence we have of the fact? I do not propose to enter here into that evidence, more especially in the case of the one well-characterized Laurentian fossil, *Eozoön Canadense.* I have already amply illustrated it elsewhere. I would merely say here, that we should bear in mind that in this latter half of the lower Laurentian, or, if we so choose to style it, middle Laurentian period, we have the conditions required for life in the sea and on the land; and, since in other periods we know that life was always present when its conditions were present, it is not unreasonable to look for the first traces of life in this formation, in which we find for the first time the completion of those physical arrangements which make life, in such forms of it as exist on our planet, possible.

This is also a proper place to say something of the doctrine of what is termed "metamorphism." The Laurentian rocks are undoubtedly greatly changed from their original state, more especially in the matters of crystallization and the formation of disseminated minerals by the action of heat and heated water. Sandstones have thus passed into quartzites, clays into slates and schists, limestones into marbles. So far metamorphism is not a doubtful question; but, when theories of metamorphism go so far as to suppose an actual change of one element for another, they go beyond the bounds of chemical credibility: yet such theories of metamorphism are often boldly advanced and made the basis of important conclusions. Dr. Hunt has happily given the name "metasomatosis" to this imaginary and impossible kind of metamorphism, which may be regarded as an extreme kind of evolution, akin to some of those forms of that theory employed with reference to life, but more easily detected and exposed. I would have it to be understood that, in speaking of the metamorphism of the older crystalline rocks, it is not to this metasomatosis that I refer, and that I hold that rocks which have been produced out of the materials decomposed by atmospheric erosion can never, by any process of metamorphism, be restored to the precise condition of the Laurentian rocks. Thus there is in the older formations a genealogy of rocks which, in the absence of fossils, may be used with some confidence, but which does not apply to the more modern deposits. Still, nothing in geology absolutely perishes or is altogether discontinued; and it is probable that, down to the present day, the causes which produced the old Laurentian gneiss may still operate in limited localities. Then, however, they were general, not exceptional. It is further to be observed that the term "gneiss" is sometimes of wide and even loose application. Besides the typical orthoclase and hornblendic gneiss of the Laurentian, there are micaceous, quartzose, garnetiferous, and many other kinds of gneiss; and even gneissose rocks, which hold labradorite or anorthite instead of orthoclase, are sometimes, though not accurately, included in the term.

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* Dr. Hunt has now in preparation for the press an important paper on this subject, read before the National Academy of Sciences.

The Grenville series, or middle Laurentian, is succeeded by what Logan in Canada called the upper Laurentian, and which other geologists have called the Norite or Norian series. Here we still have our old friends the gneisses, but somewhat peculiar in type; and associated with them are great beds rich in lime-feldspar—the so-called labradorite and anorthite rocks. The precise origin of these is uncertain, but this much seems clear, namely, that they originated in circumstances in which the great limestones deposited in the lower or middle Laurentian were beginning to be employed in the manufacture, probably by aqueo-igneous agencies, of lime-feldspars. This proves the Norian rocks to be much younger than the Laurentian, and that, as Logan supposed, considerable earth-movements had occurred between the two, implying lapse of time.

Next we have the Huronian of Logan—a series much less crystalline and more fragmentary, and affording more evidence of land elevation and atmospheric and aqueous erosion, than any of the others. It has great conglomerates, some of them made up of rounded pebbles of Laurentian rocks, and others of quartz-pebbles, which must have been the remains of rocks subjected to very perfect erosion. The pure quartz-rocks tell the same tale, while limestones and slates speak also of chemical separation of the materials of older rocks. The Huronian evidently tells of movements in the previous Laurentian, and changes in its texture so great that the former may be regarded as a comparatively modern rock, though vastly older than any part of the palæozoic series.

Still later than the Huronian is the great micaceous series called by Hunt the Mont Alban or White Mountain group, and the Taconian or lower Taconic of Emmons, which recalls in some measure the conditions of the Huronian. The precise relations of these to the later formations, and to certain doubtful deposits around Lake Superior, can scarcely be said to be settled, though it would seem that they are all older than the fossiliferous Cambrian rocks which practically constitute the base of the palæozoic. I have, I may say, satisfied myself, in regions which I have studied, of the existence and order of these rocks as successive formations, though I would not dogmatize as to the precise relations of those last mentioned, or as to the precise age of some disputed formations which may either be of the age of the older eozoic formations, or may be peculiar kinds of palæozoic rocks modified by metamorphism. Probably neither of the extreme views now agitated is absolutely correct.

After what has been said, you will perhaps not be astonished that a great geological battle rages over the old crystalline rocks. By some geologists they are almost entirely explained away, or referred to igneous action or to the alteration of ordinary sediments. Under the treatment of another school, they grow to great series of pre-Cambrian rocks, constituting vast systems of formations, distinguishable from each other, not by fossils, but by differences of mineral character. I have already indicated the manner in which I believe the dispute will ultimately be settled, and the President of the Geological Section will treat it more fully in his opening address.

After the solitary appearance of Eozoön in the Laurentian, and of a few uncertain forms in the Huronian and Taconian, we find ourselves in the Cambrian, in the presence of a nearly complete invertebrate fauna of protozoa, polyps, echinoderms, mollusks, and crustacea; and this not confined to one locality merely, but apparently extended simultaneously throughout the ocean. This sudden incoming of animal life, along with the subsequent introduction of successive groups of invertebrates, and finally of vertebrate animals, furnishes one of the greatest of the unsolved problems of geology, which geologists were wont to settle by the supposition of successive creations. In an address delived at the Detroit meeting of the Association in 1875, I endeavored to set forth the facts as to this succession, and the general principles involved in it, and to show the insufficiency of the theories of evolution suggested by biologists to give any substantial aid to the geologist in these questions. In looking again at the points there set forth, I find they have not been invalidated by subsequent discoveries, and that we are still nearly in the same position with respect to these great questions that we were in at that time—a singular proof of the impotency of that deductive method of reasoning which has become fashionable among naturalists of late. Yet the discussions of recent years have thrown some additional light on these matters; and none more so than the mild disclaimers with which my friend Dr. Asa Gray and other moderate and scientific evolutionists have met the extreme views of such men as Romanes, Haeckel, Lubbock, and Grant Allen. It may be useful to note some of these as shedding a little light on this dark corner of our unsolved problems.

It has been urged, on the side of rational evolution, that this hypothesis does not profess to give an explanation of the absolute origin of life on our planet, or even of the original organization of a single cell or of a simple mass of protoplasm, living or dead. All experimental attempts to produce by synthesis the complex albuminous substances, or to obtain the living from the non-living, have so far been fruitless; and, indeed, we can not imagine any process by which such changes could be effected. That they have been effected we know; but the process employed by their Maker is still as mysterious to us as it probably was to him who wrote the words, "And God said, Let the waters swarm with swarmers." How vast is the gap in our knowledge and our practical power implied in this admission, which must, however, be made by every mind not absolutely blinded by a superstitious belief in those forms of words which too often pass current as philosophy!

But if we are content to start with a number of organisms ready made—a somewhat humiliating start, however—we still have to ask, How do these vary so as to give new species? It is a singular illusion in this matter, of men who profess to be believers in natural law, that variation may be boundless, aimless, and fortuitous, and that it is by spontaneous selection from varieties thus produced that development arises. But surely the supposition of mere chance and magic is unworthy of science. Varieties must have causes, and their causes and their effects must be regulated by some law or laws. Now, it is easy to see that they can not be caused by a mere innate tendency in the organism itself. Every organism is so nicely equilibrated, that it has no such spontaneous tendency, except within the limits set by its growth and the law of its periodical changes. There may, however, be equilibrium more or less stable. I believe all attempts hitherto made have failed to account for the fixity of certain, nay, of very many, types throughout geological time; but the mere consideration that one may be in a more stable state of equilibrium than another so far explains it. A rocking stone has no more spontaneous tendency to move than an ordinary bowlder, but it may be made to move with a touch. So it probably is with organisms. But, if so, then the causes of variation are external, as in many cases we actually know them to be; and they must depend on instability or change in surroundings, and this so arranged as not to be too extreme in amount, and to operate in some determinate direction. Observe how remarkable the unity of the adjustments involved in such a supposition. How superior they must be to our rude and always more or less unsuccessful attempts to produce and carry forward varieties and races in definite directions! This can not be chance. If it exists, it must depend on plans deeply laid in the nature of things, else it would be most monstrous magic and causeless miracle. Still more certain is this conclusion when we consider the vast and orderly succession made known to us by geology, and which must have been regulated by fixed laws, only a few of which are as yet known to us.

Beyond these general considerations, we have others of a more special character, based on paleontological facts, which show how imperfect are our attempts, as yet, to reach the true causes of the introduction of genera and species.

One is the remarkable fixity of the leading types of living beings in geological time. If, instead of framing, like Haeckel, fanciful phylogenies, we take the trouble, with Barrande and Gaudry, to trace the forms of life through the period of their existence, each along its own line, we shall be greatly struck with this, and especially with the continuous existence of many low types of life through vicissitudes of physical conditions of the most stupendous character, and over a lapse of time scarcely conceivable. What is still more remarkable is, that this holds in groups which, within certain limits, are perhaps the most variable of all. In the present world no creatures are individually more variable than the protozoa; as, for example, the foraminifera and the sponges. Yet these groups are fundamentally the same, from the beginning of the palæozoic until now; and modern species seem scarcely at all to differ from specimens procured from rocks at least half-way back to the beginning of our geological record. If we suppose that the present sponges and foraminifera are the descendants of those of the Silurian period, we can affirm that, in all that vast lapse of time, they have, on the whole, made little greater change than that which may be observed in variable forms at present. The same remark applies to other low animal forms. In forms somewhat higher and less variable, this is equally noteworthy. The pattern of the venation of the wings of cockroaches and the structure and form of land-snails, gally-worms, and decapod crustaceans were all settled in the carboniferous age in a way that still remains. So were the foliage and the fructification of club-mosses and ferns. If at any time members of these groups branched off, so as to lay the foundation of new species, this must have been a very rare and exceptional occurrence, and one demanding even some suspension of the ordinary laws of nature.

Certain recent utterances of eminent scientific men in England and France are most instructive with reference to the difficulties which encompass this subject. Huxley, at present the leader of English evolutionists, in his "Rede Lecture"* delivered at Cambridge, England, holds that there only two "possible alternative hypotheses" as to the origin of species: 1. That of "construction," or the mechanical putting together of the materials and parts of each new species separately; and, 2. That of "evolution," or that one form of life "proceeded from another" by the "establishment of small successive differences." After comparing these modes, much to the disadvantage of the first, he concludes with the statement that "this was his case for evolution, which he rested wholly on arguments of the kind he had adduced"; these arguments being the threadbare false analogy of ordinary reproduction and the transformation of species, and the mere succession of forms more or less similar in geological time, neither of them having any bearing whatever on the origin of any species or on the cause of the observed succession. With reference to the two alternatives, while it is true that no certain evidence has yet been obtained—either by experiment, observation, or sound induction—as to the mode of origin of any species, enough is known to show that there are numerous possible methods, grouped usually under the heads of absolute creation, mediate creation, critical evolution, and gradual evolution. It is also true that almost the only thing we certainly know in the matter is, that the differences characteristic of classes, orders, genera, and species, must have arisen, not in one or two, but in many ways. An instructive commentary on the capacity of our age to deal with these great questions is afforded by the fact that this little piece of clever mental gymnastic should have been practiced in a university lecture and in presence of an educated audience. It is also deserving of notice that, though the lecturer takes the development of the Nautili and their allies as his principal illustration, he evidently attaches no weight to the argument in the opposite sense deduced by Barrande—the man of all others most profoundly acquainted with these animals—from the palæozoic cephalopods.

Another example is afforded by a lecture recently delivered at the Royal Institution in London by Professor Flower.† The subject is, "The Whales, Past and Present, and their Probable Origin." The latter point, as is well known, Gaudry has candidly given up. "We have questioned," he says, "these strange and gigantic sovereigns of the tertiary oceans as to their ancestors—they leave us without reply." Flower is bold enough to face this problem; and he does so in a fair and vigorous way, though limiting himself to the supposition of slow and gradual change. He gives up at once, as every anatomist must, the idea of an origin from fishes or reptiles. He thinks the ancestors of the whales must have been quadrupedal mammals. He is obliged, for good reasons, to reject the seals and the otters, and turns to the ungulates, though here, also, the difficulties are formidable. Finally he has recourse to an imaginary ancestor, supposed to have haunted marshes and rivers of the mesozoic age and to have been intermediate between a hippopotamus and a dolphin, and omnivorous in diet. As this animal is altogether unknown to geology or zoölogy, and not much less difficult to account for than the whales themselves, he very properly adds, "Please to recollect, however, that this is a mere speculation." He trusts, however, that such speculations are "not without their use"; but this will depend upon whether or not they lead men's minds from the path of legitimate science into the quicksands of baseless conjecture.

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* Report in "Nature," June 21st, corrected by the author. † Reported in "Nature."

Gaudry, in his recent work, "Enchainements du Monde Animal,"* though a strong advocate of evolution, is obliged in his final *résumé* to say: "Il ne laisse point percer le mystère qui entoure le developpement primitif des grandes classes du monde animal. Nul homme ne sait comment ont été formés les premiers individus de foraminifères, de polypes, d'étoiles de mer, de crinoides, etc. Les fossiles primaires ne nous ont pas encore fourni de preuves positives du passage des animaux d'une classe à ceux d'une autre classe."

Professor Williamson, of Manchester, in an address delivered in February last before the Royal Institution of Great Britain, after showing that the conifers, ferns, and lycopods of the palæozoic have no known ancestry, uses the significant words, "The time has not yet arrived for the appointment of a botanical king-at-arms and constructor of pedigrees."

Another caution which a paleontologist has occasion to give with regard to theories of life has reference to the tendency of biologists to infer that animals and plants were introduced under embryonic forms, and at first in few and imperfect species. Facts do not substantiate this. The first appearance of leading types of life is rarely embryonic. On the contrary, they often appear in highly perfect and specialized forms; often, however, of composite type, and expressing characters afterward so separated as to belong to higher groups. The trilobites of the Cambrian are some of them of few segments, and, so far, embryonic; but the greater part are many-segmented and very complex. The batrachians of the carboniferous present many characters higher than those of their modern successors, and now appropriated to the true reptiles. The reptiles of the Permian and trias usurped some of the prerogatives of the mammals. The ferns, lycopods, and equisetums of the Devonian and carboniferous were, to say the least, not inferior to their modern representatives. The shell-bearing cephalopods of the palæozoic would seem to have possessed structures now special to a higher group, that of the cuttle-fishes. The bald and contemptuous negation of these facts by Haeckel and other biologists does not tend to give geologists much confidence in their dicta.

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* Paris, 1883.

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THE COLORS OF FLOWERS.

By AUGUST VOGEL.

WHEN we contemplate the extraordinary diversity of colors offered to us by the numberless flowers and fruits, ranging through all possible gradations from the purest white to the most intense black, we can do no less than admire so surprising a wealth of color-shades, and are naturally prompted to imagine that chemical processes influence their tone and effect the manifold changes. Although we are able to pursue the chemical processes occasioning changes of color in the mineral kingdom—we know, for instance, those occurring during the conversion of the white color of silver chloride into black—those in the living plant, whereby equally striking changes are effected, are unfortunately hidden from our scrutiny. For instance, we do not know the process which causes the immature fruit of the prune-tree to pass from the brightest of green, through the most varying gradations of color into light red, and finally deep dark blue; although we know that during the process of maturing the percentage of starch is by the aid of the vegetable acids of the fruit gradually converted into sugar, still, this phenomenon is not sufficient to throw light on so extraordinary an alteration of hues. To the operation of light is ascribed an essential influence in determining the vegetable colors; but that vegetable pigments can also be produced without light is shown by the yellow turnips, carrots, alkanet-roots and other roots, all of which develop their colors within the soil. Not only the light in general, but also its volume, appear to exert an influence upon the intensity of these pigments and their hues. This fact is confirmed by the intense and lively colors of flowers blossoming upon high mountains, and the increase of the flower pigment of the same species of plants with the augmenting elevation, with otherwise the same properties of soil and location. This increase of the pigments, such as is observed upon the Alps and other high mountains, stands most assuredly in connection with the stronger sun radiation at great height. It has further been proved that, under the influence of the almost uninterrupted duration of light during the short Scandinavian summer, many garden flowers of Central Europe gradually increase in intensity after having been acclimatized in Norway. Imported seeds of winter wheat, corn, peas, and beans, grow darker from year to year, until they have finally assumed the hue of native productions. Not alone do flowers, seeds, fruits, and vegetables, become more aromatic in the northern latitudes, through the long constancy of light in summer, but their color also deepens, while the production of sugar decreases from the insufficient quantity of heat. Thorough experiments will reveal the effects of electric light upon vegetation, and we have no doubt that interesting results will be obtained in time, with regard to the influence of this light upon the pigment of flowers.

Our knowledge of the chemistry of vegetable pigments is not yet sufficiently advanced, for which reason the effect of artificial influence upon the color-tone of flowers has not yet received its merited attention. According to my view, tannin is an important factor in the generation of vegetable colors; it is found in almost every plant, the petals not excepted, and by the action of the most varying reagents—alkalies, earths, metallic salts, etc.—it assumes the most manifold hues from pale rose to deep black. A darker color, therefore, is produced in flowers rich in tannin, when manured with iron-salts, since, as everybody knows, tannin and iron-salts dye black, and produce ink. A practical use has been made of this fact in the raising of hortensias and dahlias. The former, which in ordinary soil blossomed pale-red, became sky-blue when transplanted into soil heavily manured with iron ochre, or when occasionally watered with a dilute alum solution. English gardeners succeeded in growing black dahlias by similar manipulations. It is well known to every florist that a change of location, that is, a change of light, temperature, and soil (replanting), occasionally produces new colors, whence it may be deduced that an interrupted nutrition of the flower may, under circumstances, effect a change of color. We see no valid reason why the well-authenticated fact of the change of color produced by manuring with iron oxide, thereby changing the nutrition of the plant, should not be practically employed by the hothouse gardener. Another very singular and successful experiment, in producing a change of color in a bird, has recently been made. A breeder of canary-birds conceived the idea of feeding a young bird with a mixture of steeped bread and finely pulverized red Cayenne pepper. Without injuring the bird, the pigment of the spice passed into the blood, and dyed its plumage deep red. The celebrated ornithologist Russ believes that the color of the plumage of birds might be altered according to desire, by using appropriate reagents.

Apart from chemical operations, there are also physical ones which, I believe, influence the color of flowers. It is a well-known fact that a most intimate relation exists between color and form. We know very well that the minute division of a pigment exerts a great influence upon its shade of color: a solid piece of vermilion does not possess the pale-red hue of the finely pulverized article; it is dark brown, and only shows a high red when scratched with a hard body, the color increasing with a continued comminution. Mercury oxide, while deep-red in a crystalline condition, becomes light orange-yellow upon continued pulverization. Deep dark-blue smalt can be converted into a perfectly colorless powder by being pulverized and washed, and no one would recognize it as being identical with the coarsely grained original article. Gold-powder, in its most minute division, does not possess the known yellow color of the metal, but a bluish-green shade, and at first glance would not be held to be metallic gold until the blue-green powder, when fused, reassumes its yellow color. When we introduce a film of gold between two transparent pieces of glass, and hold it against the sun, the rays of the latter will shine through with a bluish-green color; this transparency of gold, however, only occurs when the film is $\frac{1}{2000}$ of a line, or less, in thickness. It is indisputable that in the two instances mentioned here the appearance of color depends upon the minute mechanical division of the pigment, and with this is also connected the alteration in the color of solid bodies, when converted into gas or air. In a gaseous (therefore a very minutely divided) condition, black iodine becomes violet, yellow sulphur red, blue indigo purple. All these instances, to which numerous others might easily be added, prove the intimate connection between color and form. According to my opinion, some similar process, as far as regards form and division, possibly occurs in vegetable nature, and exerts its influence upon the multiplicity of color-shades.

Flower pigments, almost without an exception, are so inconstant and transient that they can not be employed in our industries. They, the children of light, separated from a vital union with the plant, no longer resist the effect of light—they wither and bleach in it. This is unhappily true with the most universally found of all—the leaf-green (chlorophyl). If this pigment could by some means be changed into a fast dye, the poisonous Swinefurt, or Paris-green, would have seen its last days. What an incomparable color is contained in the safflower (*Carthamus tinctorius*), which, although used as a beautiful rose in the dyeing of silk, is unhappily of an unstable nature! The same is true of the splendid yellow of the flowers of the wild *Reseda luteola.* This plant, in spite of the instability of its color, is cultivated in France, England, and different parts of Germany. The white color of various flowers—lilies, roses, and others—is generally produced by a white cellular juice, but may also be due to a white pigment, *artholeucine*, suspended in the colorless cell-juice. These white flowers would offer most suitable material for researches, if the experimental conversion of colors were undertaken. When undecomposed light is reflected by a body, its color appears to us as white. White, therefore, is no actual color, but simply a union of all colors, or the collective rays of light in an unseparated combination. By an alteration of the chemical combination in the plant, by means of an appropriate manure, it becomes possible to cause the fibers of the white petals no longer to reflect upon our eye an undivided white, but a divided colored ray. The yellow or orange coloring-matter of flowers, *anthoxan-*

thine, generally arises from the conversion of the chlorophyl. It occurs most frequently in the form of minute grains; sometimes also dissolved in the juice. Two anthoxanthines, therefore, must be distinguished in flowers—*xanthine*, which is not soluble in water, and *xantheine*, which is. The former dissolves with a gold-yellow color in alcohol and ether, is not affected by alkalies or dilute acids, but is colored green or deep indigo-blue by concentrated sulphuric acid. The soluble xantheine is by alkalies changed into brown. In the blue, violet, and red flowers (cornflower, hyacinth, violet, larkspur, sword-lily, rose, in the leaves of the red poppy, etc.), the pigment is found dissolved in the flower-juice almost without an exception. The red pigment of the rose, dahlia, peony, and other flowers, as well as that of violet flowers, is, according to recent observations, only a blue colored into red (anthocyanogen), by vegetable acids or acid salts. This is plainly proved by the acid reaction of the juice of red flowers, and the occasionally feeble alkaline reaction of blue petals, as I have universally found, with only a few exceptions.

When contemplating the boundless diversity of the hues of flowers, the very natural question involuntarily arises within us: For whom does the flower blossom in the solitude? For whom does it bloom in all its lavish beauty? No human eye beholds it, and yet it is arrayed in a pomp of hues unsurpassable in the dreary solitude, regardless of human applause. Nevertheless, we must not accept the unnoticed wealth of these manifold hues as due to accident; there is nothing accidental or superfluous in creating Nature, although we fail to perceive its purposes; Nature never wastes its energies in aimless, purposeless productions. As the song of the bird ceases when its plumage is adorned with lustrous, pronounced colors, so also are the colors of the odorous flower found to be more modest when compared with the scentless one, dazzling in the gorgeous brightness of its hues. This well-known, generally correct fact must not be treated as unworthy of consideration or due to accident. The firm belief of a definite, well-arranged connection of all earthly occurrences is deeply implanted within our breast. A well-defined law governs the varied hues of flowers, as offered us by the munificence of Nature, and it will, ere long, be revealed unto the eye of the student.

The truth of the celebrated saying of Justus von Liebig, "The knowledge of Nature is the path that leads us to the admiration of the Creator," is also verified here in the soundless laboratory of the colors of flowers.—*Westermann's Monatshefte.*

SKETCH OF DR. MAX VON PETTENKOFER.

"A CHAMPION against the Cholera" is the designation which Dr. Karl Stieler gives to the subject of this sketch, in his admirable biography of him in a former volume of "Daheim," to which we shall be largely indebted for such parts of our own article as are not mere date and detail. Since Dr. Stieler's article was written, Dr. Pettenkofer has distinguished himself by intelligent and thorough investigations in other forms of disease and in more extended fields of sanitary science, to the practical results of which it is impossible to attach too much value.

Max von Pettenkofer was born December 3, 1818, at Lichtenheim, a quiet rural estate not far from Neuberg, on the Danube. When it came time to prepare for his life-career, he went to pursue his studies at Munich, where his uncle was court pharmacist, and there he occupied himself with such branches as were prescribed for students who intended to become physicians—branches which were sharply laid down in an inflexible course, for it at that time seemed a waste, says Dr. Stieler, to study anything that did not pertain to the class-examination. Happily, these studies were suited to the young man's taste; and, when he was graduated Doctor of Medicine in 1843, they pointed to the way which he had chosen. After graduation, led in that direction by Fuchs, he turned his attention to chemistry, and pursued that science, with physics, at Munich and Würzburg, and under Liebig at Giessen, steadily keeping his eye fixed on the relation of these branches to the healing art. In 1845 he was assistant in the chief office of the mint in Munich. In 1847, when not quite twenty-nine years old, he began his work as an academical teacher by accepting an appointment as extraordinary professor in the medical faculty at Munich. Six years later, in 1853, he became a regular professor, having in the mean time succeeded his uncle as director of the court pharmacy. Under his management this establishment became a real scientific laboratory. His first labors were predominantly technological, and related to the affinities of gold, the preparation of platinum, and the hydraulic lime of England and Germany. He also found a process for obtaining illuminating gases from wood, and investigated hæmatinon and aventurine glass. He made studies in oil-colors, in the course of which he discovered a valuable method of preserving oil-paintings.

The peculiar and most evident direction, however, in which his activity manifested itself was in the field of public hygiene, in which he has accomplished an extraordinary amount. His first important efforts in this region were his investigations of heating by stoves and by air, of the conditions of house-ventilation, of the influence of soil upon health, and of the physical relations of clothing. In short, this new domain of knowledge opened itself to him on all sides. The conviction had grown up in Germany that the care a people takes for its public health may be regarded as an index of its advance in civilization. This care, he taught, concerns not only the healing of diseases, but even more the guarding against them; by the side of the care for the sick should stand a regard for the preservation of health, which should avail itself of the most recent results of science, and should be exercised by the state as one of its most pressing duties. That these views so made their way in Bavaria that professorships of hygiene, of which he was assigned to that in the University of Munich, were established in the high-schools of that kingdom, was mainly due to Pettenkofer; and the interest in hygienic matters, which was minifested in other ways, was excited chiefly by his motion.

Hygiene of course acquired an increased importance during epidemics, when disease threatened not individuals only, but whole cities and countries. With this category we enter upon the region which Pettenkofer has made the objective point of his activity. The investigations which he published on the nature and spread of the cholera enjoy an authority that is hardly limited by geographical boundaries. Here, indeed, Science has to contend with many unknown factors, and we should contradict the views of our active investigator himself if we should assume to speak of conclusive results. Nearly all in the present theories is provisory; the most varied points of view are opposed one to another; but, notwithstanding this, the beginnings that have been made, and the few fixed points that have been verified with respect to the questions, are a priceless gain. Hardly any other kind of affliction, observes Dr. Stieler, has been in the past so surrounded with superstitions as that of great epidemics. Thousands of persons were murdered in the middle ages on charges of poisoning wells; and, even after this kind of barbarism had disappeared, the terror remained which every danger excites, before which we stand ignorant and defenseless. We have now entered an age of correct discernment; intelligent investigation has taken the place of superstitious fear, and has neutralized its grievous effects by seeking and finding out natural causes. The ghostly element which seemed peculiar to these diseases has been destroyed, for it is no longer able, after the fashion of ghosts, to evade every attack, but has been made accessible and tangible, like every other enemy. Dr. Pettenkofer has had a great part in bringing about the revolution that has taken place, by taking hold of the ghosts, as it were, and compelling them to stand and receive his attacks; and, instead of resigning himself to their supposed machinations, he has taken the chief and leading part in contending against them. His researches have established, however much we may still contend respecting the ultimate origin of cholera, that three conditions appertain to its outbreak in concrete cases, which may be designated as local, temporal, and that of the individual disposition. What we call the locality must have the infectious matter concealed within itself before persons abiding there are affected. Not every time is alike favorable to the infection; and, when place and time concur, only those persons are affected who offer a suitable personal disposition to the poison. Such persons, even in the worst cases, form hardly five per cent of the population. Thus, the spread of cholera is found to be governed by three factors, the operation of which can be comprehended by all. Further, Dr. Pettenkofer has taught that the danger of attack with cholera does not ordinarily come from persons who are sick, but primarily from the place, showing that the physicians are no more liable than others, and greatly relieving the duty of caring for the sick of its most formidable terrors. The rules respecting disinfection, the discovery of a term, not longer than fourteen days, to which the prevalence of cholera in a particular house is limited, and the prescription of the measures which every one should adopt in the matters of food and drink, clothing and cleanliness, are points of great value for the saving of lives, in which, says Dr. Stieler, Dr. Pettenkofer's determinations have been most definite. If any one makes the objection that these rules contain nothing particularly new, the answer is returned that modern medicine no longer deals in mysterious receipts, but is associated with the nearest and most diversified elements in our life, which not every one knows how to satisfy, or which are neglected because they are commonplace, every-day affairs. It appears now to be the chief purpose of hygiene to convince the masses that the commonest matters are the most important. No science can be less aristocratic, none has to be more intent on popularizing its results. In this popular spirit Dr. Pettenkofer prepared his treatises on "What we can do against the Cholera," and "The Present Condition of the Question of the Cholera." He was president of a cholera commission which met in Berlin at his suggestion, and was a member of the congress which met at Weimar in 1867, with similar objects. His investigations on the cholera, which were afterward extended to typhus and to the various sources of disease in the ground, the air, and the water, have given the impulse to the most comprehensive researches by hosts of inquirers. He constructed an apparatus for exact investigations in respiration, and undertook, in connection with Voit, a series of comprehensive labors on the respiration and nourishment of men and animals, through which many data were collected having an important bearing on the theory of metamorphoses of matter.

Dr. Pettenkofer's works have been published for the most part in professional journals. Since 1842 he has contributed numerous articles in chemistry and kindred subjects to "Büchner's Repertorium," "Dingler's Journal," and the "Denkschrift" of the Munich Academy of Sciences. His principal independent works are "Untersuchungen und Beobachtungen über die Verbreitensart der Cholera" ("Researches and Observations on the Way in which Cholera is spread," Munich, 1855); "Hauptbericht über die Choleraepidemie von 1854 in Bayern" ("Principal Report on the Cholera Epidemic of 1854 in Bavaria," Munich, 1857); "Ueber den Luftwechsel in Wohngebaüden" ("On Change of Air in Dwelling-Houses," Brunswick, 1858); "Die Atmosphärische Luft in Wohngebaüden" ("Atmospheric Air in Dwelling-Houses," Brunswick, 1858); "Cholera regulativ von Griesinger, P. und Wunderlich" ("Cholera regulation, by Griesinger, P. and Wunderlich," Munich, 1866); "Ueber Oelfarbe und Konservirung der Gemälde" ("On Oil-Colors and the Preservation of Pictures," Brunswick, 1869, second edition, 1872); "Verbreitungsart der Cholera in Indien" ("How the Cholera is spread in India," Brunswick, 1871); "Zur Ætiologie des Typhus" ("To the Etiology of Typhus," Munich, 1872); "Beziehungen der Luft zur Kleidung, Wohnung und Boden" ("Relations of the Air to the Clothing, the Dwelling, and the Soil," third edition, Brunswick, 1876); "Ueber den Werth der Gesundheit für eine Stadt" ("On the Value of Health to a City," Brunswick, 1873); "Ueber den Gegenwärtigen Stand der Cholerafrage" ("On the Present Condition of the Cholera Question," Munich, 1873); "Künftige Prophylaxis gegen Cholera" ("Future Prophylaxis against Cholera," Munich, 1875). With Buhl, Radlkofer, and Voit, he has published since 1876 the "Zeitschrift für Biologie," or "Journal of Biology." Articles from him have been published in "The Popular Science Monthly" on the "Relations of the Air to our Clothing" (vol. x, p. 654); "Relation of the Air to our Houses" (vol. xi, p. 196); "Ground-Air in its Hygienic Relations" (vol. xi, p. 280); "Hygienic Influence of Plants" (vol. xii, p. 417); and the "Sanitary Relations of the Soil" (vol. xx, pp. 332, 468).

Dr. Pettenkofer is a member of long standing of the Academy of Sciences of Munich. In 1880 he received the Royal Order of the Crown.

CORRESPONDENCE.

BLACK REPLIES TO OSWALD.

Messrs. Editors:

DR. F. L. OSWALD'S answer in your last issue to my criticism demands a reply, for the purpose of elucidating who is in the right on questions closely appertaining to every one's welfare.

His personal allusions may be at once thrust aside as irrelevant. The reading public can not be interested in me, but presumably in my statements, whether they are true or false—not whether I am assuming, which I am not, to represent some forty thousand physicians of the so-called orthodox school.

Dr. Oswald antagonizes my statement that the tendency to dyspepsia is an inherited one, by a glittering generality. Can I "deny that from the moment of birth millions of infants are overfed and drug-poisoned"? Well, what of the millions that are not? Are they the ones who do not show any such tendency, despite the fact that some of their progenitors do? Let him produce his proofs, or hold his peace. Such an answer to overthrow an established doctrine, unless verification be produced of causal relation between the antecedents and consequents, is not worth the paper on which it is written. To illustrate: I can with equal plausibility deny that insanity is hereditary by the assumption that it arises *de novo* from a source whose reality Dr. Oswald can not deny, that millions of children are from the moment of birth overfed and then overtaxed by brain-work at school; or, in the example of consumption, that heredity has nothing to do with it, for are not millions overfed and lung-poisoned by impure air from the moment of birth? Such is the style of sophomoric inanity which assumes to overthrow the doctrine established by vital statistics and by the observation of all competent men, that all organic defects, whether inherited or slowly acquired, are transmissible qualities.

Dr. Oswald answers to his inconsistency of cleansing his outside skin with soap and water, and allowing his much-abused and betimes very filthy inside one—the alimentary mucous membrane—to cleanse itself, by the inquiry, "Does Nature ever protest against soap and water?" She does, as every practical physician well knows. Turn to any standard author on skin-diseases, and the use of any kind of soap will be found to be prohibited in some cases, especially in those whose cuticles, like homœopathic remedies, are far too tenuous. The striking benefit of a cleansing cathartic which men and women often feel, after having suffered for days from a dead, heavy, aching languor, is such a common realization that Dr. Oswald may save himself the trouble of elaborating a specious theory to prove them deluded, for facts are such stubborn things.

And this brings me to the silly slang characteristic of all kinds of quacks—their never-ending harping about "poison-drugs." It is their shibboleth, the great hope of gain to themselves by acting on the fears of the afflicted. What is a poison? It is any substance taken into the body which with more or less rapidity tends to destroy life. This embraces every substance except foods, air, and drink—from the clay eaten by the Brazilian, to the alcohol in the beer of the Teuton. Do a few grains of santonine, to expel lumbricoides from the bowels, tend to destroy life or to preserve it? Do a few ounces of alcohol, to tide failing vital power over a dangerous depression, tend to destroy life or to preserve it? Do a few doses of quinine, to arrest an ague-chill, tend to destroy life or to preserve it? Or, to put the query in another form, Do the effects of the santonine, the alcohol, and the quinine, tend to aggravate or to render the disorders for which they are given more dangerous? Even a Dr. Oswald, or a Dio Lewis, who contradicts the almost universal experience that they tend to preserve life instead of destroying it (that is, do not act as poisons), may be asked for the evidence to show that nearly all the world are wrong, and they only are right. If a few doses of quinine could produce profound and dangerous vital disturbances at all approaching those of the fever for which the medicine is given, then Dr. Oswald might have at least one string to his harp. If, after taking fifteen grains of quinine, he was seized with a severe chill—with burning fever, with aching misery in every bone and nerve of his body—with vomiting, with protracted debility and wasting of the body, and, after a few doses more, with a congestive chill, ending life in a few hours, then Dr. Oswald might with good reason take up the battle-cry of quackery, "Poison! poison!" Until Dr. Oswald proves that the quinine *does not* preserve from these very dangers to health and life, leaving no ill effects except those that belong to the disease—his *ipse dixit* about drug-poisoning is on the same level and has exactly the same value as the venal drivel of other quacks whose shibboleth he adopts. Let me say to him that enlightened therapeutists give medicines nearly always on account of the fact that they can communicate certain kinds of energy to deranged functions, to modify, exalt, or depress—as may seem needful—in order to save life.

When a supercilious theorizer, a man who has not for a long series of years anxiously wrestled with the problem every day of his life how the sick can best be made well, thinks he can solve it far better than the tens of thousands who have so wrestled, one can only feel contempt for his inordinate vanity—to be merged into pity when he carries his bigotry about drug-poisoning so far as to leave Nature to war unaided with the putrescence of syphilis rather than take the potassium iodide. The outcome to such blood is its evolvement into extinction, as it deserves to be.

It is, Messrs. Editors, scarcely likely that one who had the privilege in his youth of sitting under the tutelage of such a master of organic chemistry as the late Professor Draper should not know the very elementary fact that digestion is a chemical process, or that he would fall into the blunder of a Dr. Oswald, who, in the last paragraph but one of his answer, writes of digestion and assimilation as being one and the same thing. But better things can not be expected of any one who quotes Dio Lewis, Graham—*et id genus omne*—as authorities in sanitary science, in place of Pettenkofer, Parkes, and Richardson. It is allowable to speak to the popular reader of a large meal as a load for the stomach, but it is presumable that Dr. Oswald, in his wrath at the application of a mechanical term to that process, is not acquainted with the views of some acute, recent philosophers, who think that all the phenomena of the universe can be explained on the laws of mechanics, from the motions of molecules up to those of the celestial masses.

Dr. Oswald asks, has observation not taught me that "the chronic hunger of the dyspeptic is as abnormal as the poison-thirst of the confirmed drunkard." Few things could more conspicuously display a man's ignorance of physiology and pathology than such a question. Not to enter into the several forms of dyspepsia, let me take the most common—a chronic deficiency of gastric juice to convert food into peptone. In such instances there is a dread of eating on account of suffering, with hunger because of the poverty of the blood and the gaunt wasting of the body from inanition. Yet the normal craving for food in a state of semi-starvation is held by our doctor as identical with the abnormal craving for alcohol by the diseased nervous system of the drunkard! The true remedy for the craving of the drunkard is complete abstinence from alcohol. Does Dr. Oswald, to carry out his parallel, recommend entire abstinence from food as a cure for the hunger of dyspepsia? Or would our astute M. D. prescribe a good large "drunk" once in twenty-four hours, even as he recommends one good large meal at a like interval for the dyspeptic? The ability to carry out the latter plan would take the tough *physique* of savages to endure, these being the order of men which he holds up for us to copy in our gastric performances. Dr. Oswald is apparently unable to discern that all the customs and habits of savages are intimately correlated to their vital organism, and that for us to adopt only one of them might prove murderous to civilized beings. For instance, among the sixty generations of barbarians of which he writes, all the weaklings were killed off in infancy by its perils; now, we nurse them up to adult life, and Dr. Oswald proposes to cure them of their weakness by the adoption of a savage habit—the one-meal-a-day system.

Perhaps Dr. Oswald will find that, in uttering a gratuitous insult in the closing sentence of his communication to that large body of medical men to whom alone is due the entire credit for all the great discoveries and improvements in anatómy, physiology, etiology, hygiene, pathology, surgery, gynæcology, materia medica, and practice, he has only succeeded in belittling and defiling himself. J. R. Black.

MORE SUPPOSED PRE-GLACIAL HUMAN TRACKS.

Messrs. Editors:

I noticed in a recent issue of the "Monthly," a note in the "Miscellany," referring to the presentation of fossil remains of the primitive horse by Professor Leidy, that the remark was made by Professor H. C. Lewis that, while evidences of post-glacial man were frequent, it was not known that any scientific observations of pre-glacial man had been found either in Europe or America, etc., etc. I wish to bring to the notice of the scientific men of America and Europe an incident which occurred in the town of Chatham in this State, some six or seven years ago, and which seems to me to distinctly prove the existence of pre-glacial man more decidedly than anything else that has come under my observation.

The town of Chatham, as may be seen by reference to the map, lies at what has been termed the "elbow of Cape Cod." It is exposed to the full sweep of the waves from the broad Atlantic, which during the storms from the southeast beat upon its shores with tremendous force. It was during such a storm—the exact date of which I can not now state—that the bluff upon which stood the two light-houses, was rapidly undermined; the bluff here was, on an average, some forty or more feet in height, and, like all the rest of the cape, was composed of drift. The lamps were removed from the two towers, and one of them soon after fell over; the previous morning they had stood nearly four hundred feet from the bank. The *detritus*, by the heavy pounding of the surf, was cleaned out, revealing the fact that the bottom, for half a mile along the line of coast, and more than one hundred yards landward, had been uncovered, and consisted of a hard blue clay, in which were imbedded many trunks of trees, and that the whole surface was covered with tracks of animals of different sizes and shapes; while, proceeding in a diagonal direction from the still-overhanging bluff, to the sea, were the perfectly preserved tracks of five pairs of naked human feet, evidently those of a woman and four children of different ages; three were upon one side of the woman and one upon the other. The tracks, as I have been assured by the most intelligent men of the place,[*] were as distinct and perfectly preserved in the clay bottom, as though made but the day before; they all had the same peculiarity noticed in those who live a free and unrestrained life—that the toes were not turned out, but that the step was straight forward. Around one stump, broken off several feet above the surface upon which these tracks appeared, were many confused tracks, and much hair.[†] From reports made me, I judge it must have been some animal of the deer or bison family, scratching himself upon the sharp, broken fragments of the stump. I sent some of the hair to the Secretary of the Museum of Natural History of Boston for a microscopical examination. Although quite a number of months have elapsed, no report has been made to me as yet of the result of it, although one was speedily promised at the time I sent it.

The question that appeals to the scientist for solution is, "When were these human foot-prints made?" It is one more easy to be asked than answered; yet it is plain to any observer that they could only have been made prior to the Drift epoch, which piled, by glacial action, over forty feet of stones and dirt above them. This deposit was made—or at least begun—suddenly. We see too many tracks to allow us to believe that this bottom could have been at the ancient sea, for then the tidal action and storms must have obliterated the impressions; for they were too numerous and of too diverse a character to permit the idea that they did not require a considerable period of time for their formation; the children were walking along by the side of their adult companion, without fear or hurry; close by where they passed, an animal "with feet as large as a big ox's, and the same shape," before or after they passed, relieved himself of his winter's growth of hair; for the hair was all of four or five inches long, and was trodden into the clay, and adhered to the stump in large quantities. There were also marks of feet showing a most perfect *fac-simile* to the bear of to-day—some form of *plantigrade*, surely; and they would not have taken the course they did had not the coast been clear. It was spring when this was covered by the drift, for this animal was not only getting rid of a heavy coat of hair, in immense quantities, but the woman and children were barefoot, conclusively proving that the weather, at the time these impressions were made, was moderately or quite warm, and that it was in the early spring; that a severe winter was the rule, by the length and great abundance of the hair rubbed off by this bison, moose, or elk, or whatever he might be; that the coast-line was lower than it now is, as proved by the growth of trees, which served the people living near the beach for fuel many weeks. But the great question of *when* all this took place, is one that I leave for others to answer. The fact that the whole of Barnstable County, commonly known as Cape Cod, shows, in all its parts, unmistakable proofs of long-continued glacial action, with large bowlders thickly planted in many localities; while, by boring for wells in nearly all parts of the town of Chatham, down to a depth of thirty feet or thereabout, evidences of the drift only are found, and then a stratum of blue clay to an unknown depth; and that this same clay is found all over the cape at varying distances from the surface—would mark it as the original pre-glacial bottom, and the impressions I have mentioned those of the true aboriginal inhabitants, belonging to the Pliocene period. C. J. Ricker, M. D.

Newton, Mass., *May* 12, 1883.

HOMŒOPATHY AND QUACKERY.

Messrs. Editors:

In the June number of "The Popular Science Monthly" is an article on "Quacks and Quackeries," which, in its allusion to homœopathy, should not go unnoticed. The very fact of homœopathy being classed with quackeries is an insult to the nearly nine thousand physicians of that school in the United States, and their hundreds of thousands of patrons from the most intelligent and enlightened portion of the community. The writer of the article makes an utterly unfair and garbled presentation of our system of medicine, and some of his statements are absolutely false; as, for instance, he pretends to quote from an address delivered at the meeting of the American Institute of Homœopathy, held in Milwaukee in 1880. I have before me the proceedings of that meeting, and there is absolutely nothing, from the first page to the last, that could be even willfully distorted into such a statement as he makes regarding the progress of homœopathy. As for the legal recognition of homœopathy, let our fifty-four hospitals, our twelve fully-equipped colleges, our forty dispensaries, our medical departments in State universities, our insane asylums and hospitals under State and city patronage, speak for themselves.

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[*] One of the principal gentlemen from whom the above information was derived is Captain George Eldredge, author of "Eldredge's Charts," "Eldredge's Coast Pilot," etc. Another is Levi Atwood, Esq., editor of the "Chatham Monitor." Both these gentlemen live in Chatham, and from long personal acquaintance I can speak highly of them as men of truth and general trustworthiness. Both they, and many others, equally reliable, will confirm all the facts I have stated above.

[†] Captain Eldredge told me he should judge that, were it all collected, there would be two quarts of it. He showed me some that he had gathered and preserved; it was coarse, reddish-brown, and about four inches in length, or varying from three and one half to four and one half inches long. It may be well to state that after a few storms the whole of the uncovered portion was covered once more with sand, and all these wonderful phenomena were obliterated. Under the bluff are yet concealed sights, perhaps still more useful to archæology.

As a reader of your excellent journal for many years, I protest against such treatment of a recognized system of medicine, and trust that you will permit a fair and just presentation of homœopathy to be made in the journal.

Respectfully yours,
H. R. Stout, M. D.

Jacksonville, Fla., *July* 2, 1883.

INTELLIGENCE SHOWN BY ELEPHANTS.

Messrs. Editors:

The article on the "Mental Capacity of the Elephant," in the August number of "The Popular Science Monthly" was of much interest, and I beg to add a few more instances of the intelligence shown by these animals. In my childhood, when circuses or menageries exhibited near my home, it was my custom to rise early the next morning and feed the elephants with biscuit and grass. On one occasion, an elephant seemed to be trying to attract my attention, and when I approached he began moving the end of his trunk over the surface of his body, as if to rub himself, but not touching it. It was his method of begging in pantomime for a piece of wood. I picked up a piece of the thin end of a shingle, about the size of a page of "The Popular Science Monthly," and gave it to the elephant, so that he would be obliged to take it on the side, thinking that he would break it when it was put to use. To my surprise, after looking at the piece of shingle, he dropped it and picked it up by the end, and scratched himself, without breaking it. It has always seemed to me that this act of pantomime, and subsequent use of a piece of wood in the direction of maximum strength, involved a higher degree of animal intelligence than I ever saw exhibited elsewhere.

I attended Forepaugh's circus at Brockton, Massachusetts, on the 8th of last June, and I recollect seeing other feats than those cited by Mr. Hornaday, such as tilting on a see-saw, sitting with the fore-legs straight, "like a cat," and then saluting with the trunk; also dancing in various steps. But, shortly after the afternoon performance, two of the elephants were called upon to perform a task requiring more intelligence than any of the conventional ring feats. The facts are given in the following extract from the Boston "Herald" of June 10th:

> The incident referred to took place on the fair-grounds at Brockton, where Mr. Forepaugh's show was exhibiting. Shortly after the *matinée* performance had concluded, a one-story frame building, used as a police-station, caught fire, and in a few moments the entire building was enveloped in flames. Attached to the station-house was a row of horse-sheds, and connecting with the latter was the grand stand, in close proximity to which were Mr. Forepaugh's tents. There being no fire appliances on the grounds, it may well be assumed that the burning building gave serious alarm to the circus-people, as well as to the citizens, many of whom had not yet left the grounds. At this juncture, Mr. Forepaugh and his general manager, C. W. Fuller, appeared on the scene. It was plainly apparent that, unless the horse-sheds were torn down, the grand stand would burn, and, in that event, the destruction of the circus-tents was inevitable. While all were excited and making futile attempts to pull down the building with their hands, Adam Forepaugh, Jr., came running up, and, taking in the situation at a glance, called his colored assistant and hastened to the elephant quarters, soon after appearing with Bolivar and Basil, the latter being next to the former in point of size. The two huge beasts were hurried over to the fire, and, much to the surprise of the spectators, began pulling down the horse-sheds, in obedience to the direction of the junior Forepaugh. The by-standers removed the *débris* as fast as it accumulated under the mighty blows of the elephantine firemen, who seemingly looked upon the affair as a matter of little moment. In an incredibly short space of time the horse-sheds were demolished, the grand stand was saved, and the circus-tents loomed up as proudly as ever.

C. J. H. W.

Boston, *August* 1, 1883.

ASSOCIATION OF COLORS WITH SOUNDS.

Messrs. Editors:

In the August number of your "Monthly" you present a translation of a notice on the "Association of Colors with Sounds." The phenomena in question occur also in the sphere of other senses. Two Zurich students[*] notice association of sounds with lights: e. g., to one subject the full moon looked at through a red glass brings up the sound of an *l* joined to an *o*. Tastes, smells, even the shapes of bodies, pains, warmth, and cold arouse color visualizations in some subjects. All these are far less common than "color-hearing," and more vague as well as individualistic. While in some instances the "photism," or associated color, is distinct for every note in the octave, and even for the overtones, in the associations with sounds, those with tastes, smells, etc., are barely more distinct than that fine, pleasant tastes and smells suggest bright colors, and contrariwise.

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[*] Bleuler and Lehmann, "Zwangsmässige Lichtempfindung durch Schall," etc., Leipsic, 1881.

There seems to be an appropriateness in these general associations somewhat as we find in such expressions as a "*sweet* child." No one, I venture to say, if asked to associate colors with sounds, would make light colors correspond to low notes. More than this: Bleuler and Lehmann give a table of the number of cases in which certain colors are the "photisms" for the different vowel-sounds. On asking several persons to force themselves to make similar associations, I was surprised to find how well their answers agreed with the table. The answers were sometimes given with great reluctance, and, when evidently little more than guess-work, often disagreed with the tables.[*]

In the case of musical notes, tastes, smells, etc., the association seems to be effected by the "*sensational* element chiefly, if not entirely," in the vowel associations, and still more, in those with words, an "*intellectual* element seems to play a part." The sight as well as the sound of some letters and words brings up the "photism." We all know that some words have a *character;* words alike in meaning, the one of Latin, the other of Anglo-Saxon origin, often differ more in *character* than in anything else. In some cases it seems to be the *character* that forms the ground of association.

We find also visualizations of numbers; by some they are seen rising in a scale up to ten or twelve, and then breaking off, by others going around the body, and in one case even moral character and sex are attributed to them. These associations seem to be taken out of the sphere of the senses into that of the intellect. It is to be noticed that the *intellectual* associations are more individualistic than the *sensational* ones. The "photism" of the same *tone* is probably similar in two persons; if the same word, probably entirely different.

Of 596 persons (383 males, 213 females) examined, 76 cases were found, i. e., about 12½ per cent. Slightly more (proportionately) cases were found in females than in males. The young seem to be subject to these visualizations rather than the old; the educated than the uneducated. The tendency to these phenomena seems to be hereditary.

There are many interesting and curious facts to be noted in these phenomena; the time for their explanation has not yet come. The method that seems most promising is that of careful compilation and judicious comparison of individual cases; and I take the liberty of adding that I would be very much indebted to your readers for any reports of similar phenomena observed in themselves or others. JOSEPH JOSTROW.

GERMANTOWN (PHILADELPHIA, PA.),
August 1, 1888.

EDITOR'S TABLE.

THE MINNEAPOLIS MEETING.

WE are gratified in being able to report that the recent meeting of the American Association for the Advancement of Science, held this year at Minneapolis, was most satisfactory and successful. It was, of course, not so large as it would have been if convened in a more central and accessible place, but we have attended smaller gatherings of this body a good deal nearer the seaboard. About three hundred members were in attendance, which, considering the obstacle of distance to be overcome by many of them, shows that there is a strong and well-sustained interest in the work of the Association. But the success of such a meeting is by no means dependent upon the extent of the congregated membership, for it may be assumed that those present were mainly selected by the earnestness of their interest in the objects of the organization. A successful scientific meeting, so remote from the great centers of population, is the best test of the vigor and prosperity of the body. No doubt it is desirable that it should most frequently meet at points of average accessibility; but, as the policy of the Association embraces the whole country in the sphere of its influence, and as it is designed, at least partially, to encourage the popular interest in science by visiting successively all the leading cities, it is well that outlying places should not be habitually neglected. The strangers were welcomed with the most hospitable entertainment by the citizens of Minneapolis, and everything was done to make their visit agreeable.

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[*] In one case the answer to the call for an association with *o* was "*o*range, but it may be because that begins with an *o*." Bleuler and Lehmann give an exactly similar case when the color was visualized. Even more accidental circumstauces than this form the ground of such associations. I found one person to whom Sunday always calls up the color blue (similar cases are reported by the Zurich students), and who traces the circumstance to his having worn a blue frock on Sundays in early childhood.

The work of the American Association on this occasion was excellent on the whole, and does not suffer by comparison with that of previous gatherings. There was a large list of papers of quite average merit, and some of them of unusual interest. Able addresses were delivered by the chairmen of the sections, and the one by Professor Rowland, of Johns Hopkins University, before the Section of Physics, we hope to give our readers in the next number of the "Monthly." The retiring president, Principal Dawson, of Montreal, gave an able address on "Some Unsolved Problems in Geology," the first part of which will be found in our columns this month. It is mainly devoted to a discussion of the evolution hypothesis, of which Dr. Dawson can not be claimed as an adherent, and he improved the occasion to give a forcible exposition of its difficulties from the geological point of view. It is undeniable that these difficulties are many and formidable, and it will, no doubt, take a long time to clear them up, while the solution of still unresolved problems will very possibly result in important modifications of the theory as now entertained. But the establishment of the doctrine of evolution as a comprehensive law of nature is no longer dependent upon its freedom from embarrassments or that absolute completeness of proof which will only become possible with the future extension of knowledge. Notwithstanding these drawbacks, the evidence for it is so varied, so consistent, and so irresistible, as to compel its broad acceptance by men of science, who, while disagreeing upon many of its questions, acknowledge that it is now indispensable as a guide to the most multifarious investigations. It is gratifying to observe that the spirit of passion, dogmatism, and prejudice, which has been so rife in connection with this discussion during the past generation, is measurably subsiding, and that the controverted questions that remain are considered with increasing calmness, candor, and loyalty to truth.

CONCERNING QUACKERY.

Some offense has been taken at parts of Dr. Shepherd's article on "Medical Quacks and Quackeries," which appeared in our June issue. The writer ranked homœopathy as a form of quackery, and cited certain of the dogmas of Hahnemann, founder of the school, in justification of his charge. "The Popular Science Monthly" is censured for lending the weight of its authority to this accusation, and we have received sundry replies to Dr. Shepherd's strictures, of various merit, one of which, from an eminent source, is herewith printed.

It seems hardly correct to charge the "Monthly" with lending its influence to partisan objects in this matter, because the expression of an opinion on the part of a contributor by no means commits the magazine to it. Many periodicals advertise that the editors do not hold themselves responsible for the views of their writers: we have not done this, because it seemed superfluous. We often print statements with which we do not agree, and sometimes express dissent; but it by no means follows that a failure to protest is to be construed into an indorsement of all that appears in our pages; while certainly no one would expect that we should limit ourselves to printing only that which perfectly accords with our own notions. That we are not partisans in this matter should have been inferred from our frequent habit of giving replies to one-sided statements, as is done in the present number, and also from the fact that we have published sharp reflections upon the regular school of medicine. The article entitled "Quackery within the Profession," which appeared in the March number of the "Monthly" of last year, sufficiently attests this: it was an unsparing denunciation of the quackish tendencies that are growing up within the limits of the old orthodox medical school.

We are much inclined to accept the view taken in that article, which is that "*systems* and *cures* of any class or description" adopted by any school of medicine are of the nature of quackery. We agree with the writer when he says: "There is no system, or cure, or charm, or nostrum, known to the profession; our calling consists solely in the rational study and treatment of disease on common-sense principles." Whether a valid "system" of practical medicine will ever become possible is doubtful, but it is sufficiently certain that the present state of science does not warrant it; and, in this condition of things, any one method of cure to be generally followed must be misleading and injurious. Yet, to the mass of the people, there is something fascinating in a medical theory that can be put into a neat and simple formula. And the effect of this is more pernicious in proportion as these formulas are made the rallying-cries of the different schools of medical practice. These schools are candidates for popular favor. The patronage of the physician comes from the people; the people are ignorant and prejudiced, and easily taken by catch-words and clap-trap; while the doctors, as a class, are sufficiently human to avail themselves more or less of this state of facts in the way of business. The tendency of practitioners is to magnify the differences among the several 'pathies, and thus to favor the notion that some one of them contains the fundamental truth, while all others are essentially erroneous, and, as the people are generally educated to identify themselves with sects and parties, they are well prepared to become partisans in the matter of medical treatment. Thus doctors and laymen react upon each other to strengthen injurious prejudices. As Dr. R. O. Beard remarked, in an article upon "The Schools of Medicine," which we printed last February: "Rooted in the professional ignorance and bigotry of almost a century ago, fostered by the bitter rivalries and exclusivism of opposing theorists, these differences have been taken up and fed by popular opinion, until they seriously embarrass the progress of medical knowledge, and tend to destroy all faith in the science and art of healing. The medical fraternity at large, and of both schools alike, is responsible for this unfortunate condition of affairs. When professional men, who, supposably, represent the best phases of liberal thought and scientific culture, lend their names to the partisanship of mere theory, and array themselves under sectarian titles which signify their adherence to an exclusive dogma, it is small wonder that the laity should follow in their footsteps, and cast their views into the yet narrower mold of unreasoning prejudice."

The fact is, medical practice is far in advance of medical theory. Physicians can do a good deal more than they can explain. The advice of the old judge to the young judge—"Refrain from too much expounding, for you will generally be right in your decisions and wrong in your reasons for them"—is not without its bearing upon the medical profession. Medical philosophizing may be well, but it must be kept within limits, or it will certainly mislead in practice. The doctor who has a hobby in which he profoundly believes will be dangerous in the sick-room. The most important revolution in medicine that has ever taken place is that modern change of view by which the practitioner leaves more and more to nature in the conduct of his art and, as a consequence, assigns an ever-increasing value to hygienic considerations.

In regard to homœopathy, there can be little doubt that its practical influence has very much coincided with the inevitable modern tendency to abandon heroic treatment, and give nature a better chance. But homœopathic theory is quite another thing. Dr. Bayard, in the paper we publish, written to vindicate its claims, says that "homœopathy, as a science, is the law of the vital force"; and, again, "disease is the impairment of the equalization of the vital force." But the most advanced scientific thinkers are seriously asking, Is there any such thing as the vital force? or, if there be such a thing, what is it? Certainly it is a something which played a far larger part in medicine when the scientific knowledge of life was in its lowest condition. Everything in the organic economy not understood was then ascribed to "the vital force." Every step of physiological progress has consisted in wresting something from "the vital force," and explaining it in some intelligible way. As physiological problems have been resolved by physical and chemical principles, and taken their place among the proved results of science, "the vital force" is no longer invoked to account for them. Its sphere has, therefore, been gradually restricted, and its intrenchment is still in the narrowing field of physiological mystery. To ascribe an effect to "the vital force" is now but another way of saying that we do not understand its cause. How the mysterious and the inexplicable can become the basis of a special and distinctive science is itself something of a mystery. The article of Mr. Shipman on "Matter Living and Not-Living" will be read with interest in connection with that of Dr. Bayard.

LITERARY NOTICES.

Spencer's Descriptive Sociology: A Cyclopædia of Social Facts, representing the Constitution of Every Type and Grade of Human Society, Past and Present, Stationary and Progressive. In Eight Parts, large folio. D. Appleton & Co. Price, $35.

We have from time to time made reference to this great work as its parts have successively appeared during the last fifteen years; but, having now assumed its completed or final form, we desire to call attention to it as a whole, and calculated to meet the wants of modern students in the way of a valuable work of reference.

As we have repeatedly explained, this comprehensive cyclopædia of social data is novel in form, the whole work being planned and executed with a view to the utmost facility in getting at the multitudinous facts which it records. Mr. Spencer had before him a task of great difficulty when he attempted to present the materials that are descriptive of all phases of human society within an available compass, and by a plan that shall make them in the highest degree accessible for reference, and at the same time instructive for comparative study. After long reflection and various trials, he was compelled to adopt the tabular mode of arranging the facts, which necessitated the folio form of publication, with very large pages. This, of course, was undesirable, but it was unavoidable; yet, as the work is one rather for consultation than for continuous reading, there is really an immense gain in the plan chosen by which any one of its multifarious subjects may be followed out in its broadest relations with ease and dispatch.

Of course, the first thing Mr. Spencer had to do was to arrive at a classification of those elements and activities of human society which are the objects of study by the sociologist. These elements and factors exist in nearly every human society, but with the widest differences of form and development. In low and rude communities, the parts that make up the social state are rudimental, while in the ascending grade of social progress they are developed to all degrees of complexity. Some societies, as the savages, are stationary, that is, without historic change, and the descriptions of their composition and character are therefore simple, and occupy the least space. But other communities have had a long historical development, which has, of course, consisted in the evolution of the constituent parts, and these have therefore to be separately traced through all the stages of progress.

To understand how difficult the mode of presentation was, we have but to refer to the extent of the subjects dealt with. Among the social structures and activities, are the forms of government, both general and local; industrial, educational, and military institutions; domestic relations, and the constitution of families; religious systems and ideas, and ecclesiastical organizations; ceremonial customs, and social habits; recreations and amusements; useful arts, inventions, industries, and the progress and condition of knowledge; moral sentiments, ideals, and practices, and the cultivation of taste and æsthetic art; the physical, intellectual, and emotional characters of different peoples and races; and the widely varied conditions of nature, and the environing circumstances that influence the social state. These are the fundamental facts of all communities which are to be inquired into by the student of social science, and Mr. Spencer's problem was to bring these facts into such relation by classification and tabular representation as will facilitate comparison for scientific purposes. It was indispensable that two conditions be fulfilled: In the first place, the facts required to be so presented as to bring out coexisting conditions, or to show how the various factors were combined and correlated in the social structure at any one period. In the next place, it was imperative that the movement of progressive societies from epoch to epoch should be so exhibited that each constituent should be separately traced, while at the same time the consensus of advancement is displayed. Progressive societies grow unequally. Some advance rapidly in certain lines, and slowly or not at all in others, and to deduce the laws of social growth, the first condition is that of comprehensive comparative study, and Spencer's cyclopædia is conformed throughout to the attainment of this object.

It will be seen that in the nature of the case the work must have been on a very comprehensive scale. A treatise for this purpose within moderate limits would have been good for nothing; and the treatment of the subject in the ordinary form of books would have been of but very little service. But, by getting rid of all that is superfluous, by eliminating irrelevant statements, and rejecting comment and speculation, in short, by confining the digest to the essential things concerning human society to which science must be confined in its work of estabishing general truths, it became possible to condense immense amounts of historic and descriptive matter within comparatively narrow spaces. It is the merit of Spencer's work to have accomplished this object with remarkable success. Of course, anything like a really universal description of human societies, no matter how condensed, would be practically impossible, nor would it be at all necessary. What is wanted for general instruction, and scientific induction, is an array of social data that shall largely represent all the types, forms, and grades of the social state. The greatest number of human societies upon the earth are still in the low and comparatively stationary condition, although in this respect no two are alike. A large number must therefore be studied, sufficient for the derivation of general principles, but it would be needless to extend the list to unmanageable proportions. Then there are societies which have advanced to certain stages of civilization where they have been arrested and fallen into decay. A sufficient number of these require to be represented to teach the lessons they are calculated to enforce. Then there are societies which illustrate a long and slow historic progress through many centuries, and which stand at the head of the present civilization of the world. These are selected for the study of social development in its highest degree as hitherto attained. Mr. Spencer's work covers this broad field, and is thus fully adequate for the scientific demands of the age in pursuing comprehensive sociological inquiries.

So large and laborious was the undertaking upon which he engaged and so difficult was it to command capable assistance in carrying out the project, so heavy the expense of the undertaking, both in securing the protracted services of capable assistants and in the publication of the works, which Mr. Spencer had to meet alone, and so intensely was Mr. Spencer himself absorbed in the execution of his elaborate system of philosophy, that the "Descriptive Sociology" proceeded slowly, and was published irregularly as the parts were successively brought to completion. They therefore appear in an order that was determined by the circumstances of their preparation. Of all the savage races upon the globe, the very lowest are the Negritto tribes and the Malayo-Polynesian races. These are dealt with in Part III of the cyclopædia. Seventeen examples are given as types of the lowest races, viz.: the Fuegians, Andamanese, Veddahs, Australians, Tasmanians, New Caledonians, New Guinea people, Fijians, Sandwich Islanders, Tahitians, Tongans, Samoans, New Zealanders, Dyaks, Javans, Sumatrans, Malagasy. Part IV is devoted to thirteen of the representative African races; Part V to fifteen of the Asiatic races; and Part VI to seventeen of the principal American races. These four parts exemplify the undeveloped, or the but rudely developed forms of social life which are to be taken as starting-points in studying the development of mankind. Part II is devoted to more advanced forms of society, the imperfect civilizations of which are decayed or extinct, and it embraces the Mexicans, the Central Americans, the Chibchas, and the Peruvians. This line of study is also still further pursued in Part VII, which delineates the social life and the form of civilization attained by the Hebrews and the Phœnicians. Part I and Part VIII, the first and last issued, are devoted to the sociological history of the English and the French as old historic and still flourishing civilizations. There is a more or less continuous social history of England and France, running through some two thousand years and culminating in their present high development, which makes them the best examples for tracing the slow-working agencies by which the highest social conditions have been attained. The sociology of the French is the most elaborately worked out of all, the part devoted to it being so large as to rank it as a double number.

It was Mr. Spencer's original intention to include some other societies in his project, but, as its execution threatened to become pecuniarily ruinous, he closed the undertaking with Part VIII. But the scholarship of the world owes him its best thanks for having carried this great, original, and invaluable work to such satisfactory completion as it has actually attained. The history of the advance of knowledge hardly furnishes a parallel to this enterprise. Mr. Spencer foresaw many years ago that the establishment upon a sound and permanent basis of the highest and most important of all the sciences, that of human society, would depend upon such a collection and systematization of its immense data as had never been attempted or even dreamed of by inquirers upon social subjects. All science rests upon the foundation of observed facts, and these facts must be as extensive as the generalizations to be built upon them. And, because such data were neither at hand nor forthcoming, nor deemed possible of procurement, it was held that sociology could never become a legitimate and well-grounded science. It might be a region of speculation, but it could have no valid inductive basis. Mr. Spencer perceived that there was no reason in the necessity of things for this hopeless conclusion, and he accordingly undertook the preliminary work of preparing a solid foundation for the new science. Nor is it too much to say that the issue of the first part of the "Descriptive Sociology" settled the question. So eminent an authority upon this class of subjects as Mr. E. B. Tylor, author of the "Early History of Mankind," remarked upon its appearance, "It is a sufficient answer to all disbelievers in the possibility of a science of history."

That this great work should not have been appreciated by the age to which it was offered is not surprising. The sciences that have been long established are still struggling for educational recognition, and no form of intellectual labor is so ill appreciated in these times and especially in this country as that which aims at the extension of knowledge and the establishment of new truth. But this state of things can not last. Science is destined to make its way, and the science which furnishes a new method and new aids in the study of human affairs is bound to force the recognition that has not yet been accorded. There are many gropers in the field of so-called "Social Science," and, although their results are of but little value, they attest a vague belief in the social order as something capable of rational elucidation. What we want is better methods of conducting the investigation and a truer spirit of science in their pursuit. The work here noticed, in proportion as it becomes known, is certain to be tributary in an eminent degree to this desirable end.

REPORT ON THE THERMAL SPRINGS OF THE YELLOWSTONE NATIONAL PARK. By A. C. PEALE. Author's edition. Washington. Pp. 454, with Plates and Charts.

THE report is a Part extracted from the report of Dr. Hayden's "Geological and Geographical Survey of the Territories for 1878," and well deserves the distinction of a separate publication. It gives full accounts of all the geysers and hot springs of the park, arranged in the order of the river systems to which they belong, with the history of our knowledge of them, and of the region as a whole, accompanied by illustrations tinted in the natural colors, and maps, in which each spring and phenomenon described is indicated by a corresponding number. The reader of the historical introduction will be surprised to learn how short a time these wonders, now familiar and world-renowned, have been known. John Coulter, of Lewis and Clark's expedition, was the first man who ever saw them, and his accounts of them, first given in 1810, were not believed at all. James Bridger next told of them, in 1844, and was likewise discredited. Even the newspapers were afraid to publish any of his stories. Captain John Mullan, in 1853, heard something about the hot springs and geysers from the Indians; and Captain Reynolds, in a report to the Fortieth Congress, admitted that Bridger might possibly have seen such springs as he described. The first authentic description of the springs was published by David E. Folsom in the "Lakeside Monthly," Chicago, in 1870. Other explorations were made at about this time, and other magazine articles, some of them illustrated, were published concerning the phenomena; and the first scientific accounts of the region were given by the geological surveys of 1871 and 1872.

THE DISEASES OF THE LIVER, WITH AND WITHOUT JAUNDICE. By GEORGE HARLEY, M. D., F. R. S. Philadelphia: P. Blakiston, Son & Co. Pp. 751. Price, $5.

THE author published in 1863 a monograph on "Jaundice," with observations on the special application of pathological chemistry to the detection and treatment of diseases of the liver and pancreas. With the fruit of twenty years of additional experience, he has again gone over the subject and produced the present treatise, which, although it embodies the whole substance of the original monograph, "bears no more resemblance to it than a mature adult does to the suckling from which he sprung." While the scientific principles on which both works are founded are identical, the present one is much larger than the former, and contains in a condensed form a considerable amount of clinical and scientific data that have never before been collected into one volume. As in other branches of science, many old theories have been abandoned. The work being intended for the use of the "qualified brethren" of the author, he does not undertake to discuss them, but, in order that the reader may see how many of them have been given up and how many new ones espoused, he has put his own views, in accordance with the facts and arguments expressed throughout the volume, into a concise and diagrammatic tabular form.

"BULLETIN OF THE AMERICAN MUSEUM OF NATURAL HISTORY." Vol. I, No. 4. New York: Printed for the Museum. Pp. 40, with Plates.

THE present number of the "Bulletin" is wholly occupied with a contribution by Joseph B. Holder on "The Atlantic Right Whales," in which he maintains that the black whale so called of the temperate Atlantic, which was lately introduced to science as a recent discovery, and is now after a long period of nearly total extinction rapidly increasing in numbers, "is the one which our forefathers found abundant along the Atlantic coast, from Newfoundland to Florida. It is the one which was first hunted by the Cape Cod and Nantucket whalers; and is not the one now and latterly captured in the Arctic seas." Facilities have been given for the study of the animal by the existence of five skeletons in America and Europe, and by the capture of an adult specimen in 1882 off the New Jersey coast. To the results of the author's studies of the American specimens are added criticisms of previous accounts of the right whale, and a summary of historical mentions relating to the present and allied species. Some of Dr. Holder's conclusions have been disputed by Mr. J. A. Allen.

Saxon Tithing-Men in America. By Herbert B. Adams, Ph. D. Baltimore: Johns Hopkins University ("Studies in Historical and Political Science"). Pp. 23. Price, 25 cents.

The tithing-man's duties in Massachusetts and Plymouth colonies were very much like those of the constable, and, though he was preceded by officers of that name in New England, he was a far more ancient officer than the constable in the old country. While the constable had the care of public order, the tithing-man's duties were rather connected with the preservation of order and morals in families. Originally one was appointed for every ten families. Dr. Adams follows his account of the functions of the New England tithing-man with a review of the history of the office, which he traces back to the Saxon rule in England.

Medical Economy during the Middle Ages. By George F. Fort. New York: J. W. Bouton. Pp. 488.

The author styles his work "A Contribution to the History of European Morals, from the Time of the Roman Empire to the Close of the Fourteenth Century." Its general purpose is stated to be that of an historical inquiry into the practical effect upon social life throughout the period traversed, of that singular credence which involved preternatural agencies. This belief appears to have been particularly general and controlling in respect to matters appertaining to the preservation and restoration of bodily vigor. Superstition seems to have reigned supreme down to the time of Charlemagne. From that epoch the slow growth of better ideas and a more intelligent practice may be traced, beginning with the schools fostered by that enlightened ruler, and the scholars he called around him. The scope of Mr. Fort's work includes the condition of medical art under the Roman emperors to Galen's time; the influence of the Alexandrine schools in producing a regular system of magic cures, and the progress of the magic system as a moralistic episode of the middle ages, concurrent with ancient medical text-books in the cloisters; the gradual development of the science, aided by Arabic erudition at the Italian universities; and the bloom of alchemy and astrology. Among special features receiving attention are the curative powers ascribed to gems, incantations, etc., the manner of dealing with abandoned women, and the status of physicians, of both sexes, at different epochs.

A Dictionary of Practical Medicine. By Various Writers, edited by Richard Quain, M. D., F. R. S. Fourth edition. New Xork: D. Appleton & Co. In one large 8vo vol. By 1,834, with 138 illustrations. Price, $8.

This work, which has engaged the editorial labors of Dr. Quain for several years, is a single octavo volume of some eighteen hundred pages. No dictionary of medicine so compendious, and at the same time so authoritative, has yet appeared in any language. One hundred and sixty writers contribute an immense number of articles, varying in length from a column or less to thirty pages. Each contributor "volunteered or was invited to write on a subject with which he was specially familiar"; and the list of authors is as representative of the best literature of the profession in England, Ireland, and Scotland, as any that could have been framed. If the name of a distinguished authority is missed here and there, this is only the inevitable result of there being other and sometimes younger men, equally qualified and more conveniently situated for the particular purpose. Dr. Quain's editorial resources have been, indeed, of the amplest kind; he has marshaled an array of professional talent which is not only creditable to the position of the editor among his colleagues, but creditable likewise to the profession as a whole. Those who know nothing of dictionary-editing will hardly appreciate the editorial labor that this work represents. A sense of proportion in assigning the space to the several subjects in a vast field of knowledge must be constantly and watchfully observed, along with a due consideration for the value of everything that a distinguished contributor would wish to write on his favorite theme. It is given only to a firm hand and a delicate tact to achieve success in such an enterprise; and the measure of Dr. Quain's success must be, on the one hand, the compact form and size of his dictionary, and, on the other, the endless variety of the articles and the value of the signatures that they bear. An encyclopedic undertaking of this compass and quality brings to light both the wealth of our home resources in the particular learned profession, as well as the distinctively English characteristics of brevity and point. The new "Dictionary of Medicine" will take rank with the corresponding works in other departments of knowledge, for which the English press has acquired a certain distinction abroad; and it does not surprise one to hear that steps are being taken to have it translated into more than one Continental language.

The work is primarily a dictionary of practical medicine for the use of practitioners. It includes naturally all the diseases that come more particularly within the province of the physician as distinguished from that of the surgeon; but in the numerous articles on general pathology, general therapeutics, hygiene, medical jurisprudence, diseases peculiar to women and children, and subjects on the border-land of medicine and surgery, it includes all but the most technical parts of surgery also. It is, therefore, a work in which the general practitioner of medicine will find articles, in alphabetical order, on all the subjects that are likely to come under his notice in the course of his every-day work. The direct interest of it for the laity—the interest of the subject-matter, if not of the volume itself—is proved by the liberal allowance of space given to many matters that are a concern to all educated persons. Chief among the articles of this class are those on "Nursing the Sick and the Training of Nurses" (Miss Nightingale), "Administration of Hospitals, and the Construction of Hospitals" (Captain Douglas Galton), "Public Health" (the late Dr. Parkes), "Vaccination" (the late Dr. Seaton), "Contagion" (Mr. Simon), "Personal Health" (Dr. Southey), and "Predisposition to Disease" (Dr. W. B. Carpenter). Shorter signed articles of general interest are those on "Diet," "Climate," "Health Resorts," "Mineral Waters," "Sea-Air," "Sea-Baths," "Sea-Voyages," "Sea-Sickness," "Baths," "Douche," "Hydrotherapeutics," "Exercise," "Fatigue," "Effects of Extreme Cold and Extreme Heat," "Sunstroke," "Malaria," "Periodicity in Disease," "Epidemics," "Plague," "Quarantine," "Disinfection," "Mortality," "Alcohol and Alcoholism," "Criminal Irresponsibility," "Civil-Incapacity," and many more.

Many of the subjects of that class were, of course, ably handled by the older writers; and, more particularly, diet, climate, sea-voyages, and the like, were matters familiar to the contemporaries of Hippocrates and Galen. But there are not a few articles in this dictionary of which even the headings would have been looked for in vain in a similar work as recently as fifty or sixty years ago. "Anæsthetics," "Ophthalmoscope," "Laryngoscope," "Microscope in Medicine," "Clinical Thermometry," "Physical Examination"—how great an increase in the useful power of medicine and surgery do these new titles represent! "Addison's Disease," "Lymphadenoma," "Leucocythemia," "Pernicious Anæmia," "Myxœdema," "Locomotor Ataxy," "Pseudo-hypertrophic Muscular Paralysis," "Diseases of the Spinal Cord," "Pneumogastric Nerve," "Sympathetic Nervous System"—how much is there here that is quite new and curious, and may one day be even useful! "Diphtheria," "Typhoid Fever," "Malignant Pustule," "Micrococci," "Bacilli," "Parasitic Skin Diseases," "Chyluria," "Thrombosis and Embolism," "Fatty Degeneration"—how much of progressive theory, better discrimination, and rational suggestion is contained in those! The headings "Antiseptic Treatment" and "Diseases of the Ovaries" will call to mind a degree of success in formidable surgical undertakings which no previous generation has known. It would be an endless task, and much too technical, to enter into details about these numerous additions to the catalogue of diseases, to the stock of pathological ideas, and to the resources of treatment. The enumeration will serve to show that the alleged progress of medical science can be substantiated, if need be, by full particulars. It may be more generally interesting to give some account of the modern position of medical science—of its precision, and of what its precision depends upon.

PUBLICATIONS RECEIVED.

On the Characters of the Skull in the Hadrosauridæ; and on some Vertebrata from the Permian of Illinois. By E. D. Cope. Pp. 13, with Four Plates.

"Paleontological Bulletin," No. 36. First Addition to the Fauna of the Puerco-Eocene; On the Brains of the Eocene Mammalia Phenacodus and Periptychus; and Fourth Contribution to the History of the Permian Formation of Texas. By Professor E. D. Cope. Philadelphia: A. E. Foote.

Proceedings of the Third Annual Meeting of the Wisconsin Pharmaceutical Association held in Oshkosh, August 8-10, 1882. E. B. Heimstreet, Janesville, Secretary. Pp. 98.

Ætiology and Non-Infection of Sewer Gases. By Washington Ayer, M. D. San Francisco. 1883. Pp. 25.

Study of Neglected Lacerations of the Cervix Uteri and Perinæum. By Thomas A. Ashby, M. D. Baltimore, Md. Pp. 11.

The Nature of Heat and Gravity. By William Coutie. Troy, N. Y. 1883. Pp. 19.

Remarks on Hydrophobia. By Charles W. Dalles, M. D. Philadelphia. 1883. Pp. 12.

Third Annual Report of the Astronomer in Charge of the Horological and Thermometric Bureaus in the Observatory of Yale College, 1882-'83. By Leonard Waldo. New Haven. 1883. Pp. 20.

Acute Articular Rheumatism. By E. O. Bardwell, M. D. Emporium, Pa. 1883. Pp. 7.

The Newport Natural History Society. Document 1. Newport, R. I. 1883. Pp. 15.

Signal-Service Notes, No. 4, The Use of the Spectroscope in Meteorological Observations. By Winslow Upton, A. M. Pp. 7. No. 5, Work of the Signal-Service in the Arctic Regions. Pp. 40. Washington: Government Printing-Office. 1883.

Q. P. Indexes, No. XIII. An Index to Articles relating to History, Biography, Literature, Society, and Travel, contained in Collections of Essays. By W. M. Griswold, A. B. Bangor, U. S. A. Q. P. Index, Publisher. 1883. Pp. 56.

Pemphigus and the Diseases liable to be mistaken for it, pp. 11; Hints on the Treatment of some Parasitic Skin Diseases, pp. 11; The Treatment of Various Forms of Acne, pp. 7. By George H. Rohé, M. D. Baltimore, Md.

"The American Psychological Journal." Edited by Joseph Parrish, M. D. Quarterly. Vol. I, No. 2. July, 1883. Philadelphia: P. Blakiston, Son & Co. Pp. 112. $2 a year.

The Calendar of the Departments of Law, Science, and Literature of the University of Tokio, Japan. 1881-'82. Pp. 125.

Measurement of the Force of Gravity at Sapporo, Yesso. Published by the University of Tokio. 1882. Pp. 21.

Topics of the Time, No. 4. Historical Studies. Edited by Titus M. Coan. New York: G. P. Putnam's Sons. 1883. Pp. 205. 25 cents.

Hydraulic Tables for the Calculation of the Discharge through Sewers, Pipes, and Conduits. By P. J. Flynn, C. E. New York: D. Van Nostrand. 1883. Pp. 138. 50 cents.

Die körperlichen Eigenschaften der Japaner. Eine anthropologische Studie. (The Bodily Peculiarities of the Japanese. An Anthropological Study.) By Dr. Erwin Baelz. Yokohama: Press of the "Echo du Japon." Pp. 30.

Die Kupferlegirungen, ihre Darstellung und Verwendung bei den Volkern des Alterthums. (Copper Alloys, their Description and Application with the Peoples of Antiquity.) By Dr. E. Reyer. Vienna. Pp. 16.

Revista de Agricultura. (Review of Agriculture.) Nicomedes P. De Adan, Director. Monthly; August, 1883. Havana. Pp. 32.

Muster altitalienischer Leinenstickerei. (Pattern-Book of Old Italian Linen Embroidery.) Collected and edited by Frieda Lipperheide. Berlin: Franz Lipperheide. 2 vols. Pp. 32 and 36, with 22-30 Plates. 12 marks.

First Annual Report of the Board of Control of the New York State Experiment Station, for the Year 1882. Albany: Weed, Parsons & Co. 1883. Pp. 156.

Lessons in Qualitative Chemical Analysis. By Dr. F. Beilstein. St. Louis: St. Louis Stationery and Book Co. 1883. Pp. 164. $1.50.

Genesis. The Miracles and the Predictions according to Spiritism. By Allan Kardec. Boston: Colby & Rich. 1883. Pp. 488.

God and Creation. By Robert Reid Howison. Richmond: West, Johnson & Co. 1883. Pp. 578.

Photo-Micrographs and how to make them. By George M. Sternberg, M. D., F. R. M. S. Boston: James R. Osgood & Co. 1883. Pp. 204. Illustrated. $3.

Fifth Annual Report of the State Board of Health of Connecticut, for the Fiscal Year ending November 30, 1882. Hartford: Press of the Case, Lockwood & Brainard Co. 1883. Pp. 456. Illustrated.

POPULAR MISCELLANY.

The American Association.—The thirty-second annual meeting of the American Association for the Advancement of Science was opened at Minneapolis, Minnesota, August 15th, with the usual forms. The welcoming addresses were made by the Governor of the State, the mayor of the city, and Dr. Folwell, President of the State University, in whose halls the sessions were held. The address of the retiring president, Professor Dawson, was delivered in the evening, after which the members of the Association were entertained at a citizens' reception. Professor William A. Rogers, Vice-President of the Section of Mathematics and Astronomy, read an address on the "German Survey of the Northern Heavens." Professor H. A. Rowland, of Baltimore, Vice-President of the Physical Section, made "A Plea for Pure Science," in a paper which was marked by many strong thoughts. Professor Hitchcock, of the Geological and

Geographical Section, gave a review of the "Early History of the North American Continent." In the General Sciences, Professor E. D. Cope presented in a lecture "The Evidence for Evolution in the History of the Extinct Mammalia," and Dr. T. Sterry Hunt outlined "A Classification of the Natural Sciences." The Committee on Indexing the Literature of Chemical Elements reported progress to the Chemical Section. Among the other papers read in the various sections we notice that of Professor Holden, of Madison, Wisconsin, on the total solar eclipse of May 6, 1883, and Dr. Janssen's letter on the French observations of the same phenomenon. Mr. G. W. Hough, of Chicago, discussed some "Physical Phenomena on the Planet Jupiter." Mr. O. S. Wolcott, of Chicago, considered "Some Hitherto Undeveloped Properties of Squares." Professor W. A. Rogers continued from the Montreal meeting the subject of the determination of the relation between the imperial yard and the metre of the archives. Mr. F. E. Nipher, of St. Louis, gave an account of the magnetic survey of Missouri. The Signal Service received attention in a criticism of its operations and efficiency by Gustavus Heinrichs; in an account by Professor Mendenhall, of a method for the distribution of weather forecasts by means of emblems fixed upon railway-trains, which has been tried in Ohio; and in a plan for a State signal service, by Professor Nipher. Professor Macfarland, of Towanda, Pennsylvania, endeavored to show, in his paper on "The New Madrid Earthquake" of 1811, that the phenomenon was not an earthquake, but a subsidence of land which had been undermined by limestone caverns. Julius Pohlman, of Buffalo, presented a new view of the "Life History of Niagara River"; Professor Warren Upham read a paper on "The Minnesota Valley in the Ice Age." Much attention was given to topics bearing on agriculture, in the address of Professor Beal on that subject, and in papers by Professor Richardson on the composition of American wheat, of Professor Sturtevant on maize and sorghum kernels and on agricultural botany, and of Professor H. W. Wiley on American butter. Professor E. S. Morse gave an interesting account of the manner in which he had made use of the sun's rays for ventilating and partly warming his rooms, and presented papers on Japanese games and Eastern kitchens. Among the remaining papers we remark those of Elizur Wright on "Life-Insurance and Self-Insurance"; of Professor J. C. Arthur on a sea-weed of the Wisconsin lakes which produces poisonous effects at particular seasons; of T. R. Baker on terra-cotta lumber; of Professor Claypole on the potato-beetle and the Hessian fly; of Professor Riley on an insect exterminator; and observations on caverns, and on cyclones and tornadoes. We propose to publish abstracts or full reports in future numbers of such of these papers as may be of more general and popular interest. The next meeting of the Association was appointed to be held in Philadelphia. Dr. J. P. Lesley, of Philadelphia, was chosen President for the year, and sectional vice-presidents were appointed as follows: A (Mathematics and Astronomy), Professor H. T. Eddy, of Cincinnati; B (Physics), Professor John Trowbridge, of Cambridge; C (Chemistry), Professor J. W. Langley, of Ann Arbor; D (Mechanical Science), Professor H. B. Thurston, of Hoboken; E (Geology and Geography), Professor N. H. Winchell, of Minneapolis; F (Biology), Professor E. D. Cope, of Philadelphia; G (Histology and Microscopy), Professor T. G. Wormley, of Philadelphia; H (Anthropology), Professor E. S. Morse, of Salem; I (Economic Science and Statistics), Hon. John Eaton, of Washington. Permanent Secretary, Mr. F. W. Putnam, of Cambridge; General Secretary, Dr. Alfred Springer, of Cincinnati.

Dr. Harkness on the Nevada Footprints.—Dr. D. W. Harkness has contributed a paper to the San Francisco Academy of Sciences stating his reasons for maintaining, against the arguments of Professor Marsh and others, that the Carson (Nevada) "footprints" were made by a man, "*homo Nevadensis*," and not by a quadruped. The reasons are founded on the evidence given by the impressions that they were not made by a natural foot, but by one supplied with an artificial protection. Among the points of evidence adduced by Dr. Harkness is that the marks of the pads or cushions, with which the feet of all animals are provided, and by which their foot-prints are distinguished, are wholly absent from the impressions. The absence of any evidence that the maker of the tracks had more than two feet is also insisted upon. "The curve of the foot is so regular and so constant as to show that in every instance the hind-foot—if of a quadruped—was at all times placed exactly upon the forward foot, or that both the forward and the hind feet were of exactly the same form—conditions which, to say the least, are extremely improbable." Evidence appears to be afforded in the shape of the tracks of one or two of the series that they were made by a yielding material which, like leather softened by moisture, gave way and was bent up at the sides. Unless something of this kind is admitted, the tracks must be believed to have been made by animals of different species. Other variations in the shapes of the tracks may be more readily accounted for by supposing them to have been made by sandals of different cuts than by quadrupeds having differently shaped feet. Dr. Harkness accounts for the width of the straddle, which has been urged against the human origin of the tracks, by suggesting that it would be one of the natural results of the exertion of walking in mud with the feet encumbered by such an unwieldy load as the enormous sandals.

Hygienic Qualities of Electric and Gas Lights.—Mr. B. H. Thwaite suggested, some years ago, that the intense heat developed in the arc electric light would produce a rearrangement in the gaseous contents of the atmosphere, by changing a mechanical combination into a chemical one, with the resultant development of deleterious nitrogen oxides. Mr. Wills, F. C. S., showed by experiment that ten to twelve grains of nitric acid were developed in an hour by the electric lamp. This rearrangement of gases is not produced in the incandescent lamps, for, besides the less development of heat, the filaments are kept in a vacuum. Hence, *per se*, the electric light of the incandescent type is hygienically satisfactory; but neither the incandescent nor the arc electric light assists vegetation. Besides the nitrogen oxides produced by the arc-light, says Mr. Thwaite, probably as much carbon dioxide is produced for the same illuminating power as is produced by the combustion of coal-gas. In both lights, the luminosity proceeds from the same cause—carbon heated to incandescence. The light produced by incandescent lamps is in almost perfect accord with the laws of visual or ocular hygiene, for it permits a choice of colors, but the arc-light is not so satisfactory, because it induces fatigue by its variations and its glare. The products of the combustion of coal-gas are aqueous vapor and carbon dioxide, with sulphuric acid resulting from the oxidation of the bisulphide of carbon contained in the gas. Besides these, nitrogen is set free from its mechanical combination with oxygen, but it is practically harmless. These gases may be removed by putting over the burners pipes for conveying them to the open air; and, if this were done, as it ought always to be done, the greatest disadvantage of the system of coal-gas lighting would be removed, and adequate ventilation would at the same time be provided. With regenerative burners, the intensity of combustion could be increased to such a degree that the light would be white and neutral, permitting colors of the most delicate hues to be easily distinguished. We should then have a light not only hygienically perfect, but, to the extent that it is utilized for assisting ventilation, superior in that respect to the best electric light.

Aëration of Peaty Water.—Professor W. N. Hartley and Mr. Gerard A. Kinchan, of Dublin, have made experiments with reference to the alleged power of aëration to purify the water of rivers from peaty matter they may have in solution, from which they are led to deny the existence of such power to any measurable extent. Their first experiment was made at the Powerscourt Fall of the Dargle River, where the water descends 360 feet vertically, and mostly in the form of spray. Here, if anywhere, aëration should have been general and effective; yet analyses of specimens from above and below the fall showed no variation in the amount of carbon beyond what could be attributed to experimental error. Next, samples of the water of Carawaystick Brook were taken, from distances 1,600 feet apart, between which a fall of 700 feet took place. These specimens were likewise found to be nearly identical in composition, with neither the carbon nor the nitrogen diminished by the aëration consequent upon the fall. The introduction of mineral matters often produced very much greater effects than it was possible to show to be connected with aëration, and which varied in a considerable degree according to the nature of the matters added. From his experiments on this point, Professor Hartley derives the conclusion that the peaty coloring-matter in water "acts like an organic acid, and that it is probably a body of the type of alizarine or litmus, and is only slightly soluble, or is even insoluble in pure water, but is readily dissolved in water containing traces of alkali, or of soluble carbonate, such as ammonia or potash. With metallic oxides, iron and alumina, it forms insoluble compounds of the nature of lakes. Lime-water also precipitates it. Mineral acids, sulphuric, hydrochloric, and nitric, precipitate it. Peaty water may be perfectly bright and free from turbidity. These facts, and a further observation that subsidence will not clear a peaty water of its coloring-matter, lead to the conclusion that the coloring-matter is held in solution, and is precipitated as a lake, by various mineral bases." These conclusions are applicable to organic matter of a peaty character only.

Traits of Ancient American Civilization.—Max Steffer, in a recently published book on the "Agricultural Economy of the Civilized Ancient American Peoples," declares that it is really shameful to our boasted Caucasian superiority that European agency, instead of advancing the civilization of those nations, utterly destroyed it. The relics we have of them represent the vestiges of a civilization which in its way not only yielded nothing to that of the avaricious Spaniards, but in many respects surpassed it. They furnish evidences of a thorough systematic regulation of affairs, and of the cultivation of the soil by steady industry, with careful foresight and skilled practice. The Mexican people had secured an irrigation of the soil by means of canals without machines, to which the only counterparts in Spain were the works, not more ingenious, which the Moors had left; and the Spaniards betrayed their incapacity to appreciate the value of such constructions by allowing them to go to ruin, and sometimes destroying them in the expectation of finding golden water-pipes within them. The cultivation and irrigation of the soil were matters of public interest, and agriculture was placed under similar regulations to those which prevail in China and Japan. The division of the land and all changes in possession were made under the direction of the magistrates. Many conditions in the details of management were similar to those prevailing in Japan. Both people were without yoke-animals, and their estates were so small, and their manner of living such, that the employment of such animals was not necessary. The cultivation was rather that of the garden than of the field, and, as animals were not kept, the additional land they demand was not required. In the absence of domestic animals, minute and painstaking devices to get manure, like those prevailing in China, were adopted. The Peruvians enjoyed an advantage in having guano. Like the Eastern Asiatics, the ancient Americans also had no milk, although they possessed in the llama an animal that might have furnished them that aliment, with all its products.

Hints on Furnace-heating and Ventilation.—Mr. E. S. Philbrick, C. E., of Boston, has given some useful hints in "The Sanitary Engineer" on the management of heating apparatus and furnace-ventilation. If the air-box of the furnace is not opened after a wind subsides, if it is not open enough at any time, or, if, during windy weather, the air-box is not large enough to supply all the demand, the air is often taken by natural laws from one room down to the furnace and through it, to supply another room. The former room then becomes cooled off. In the last case the rooms on the windward side of the house are always the ones cooled, for it is hard to force the air into them from the hot-air pipes, unless an open fire is supplied to draw off the surplus pressure. Open fireplaces are efficient, generally, in promoting the comfort of the family, even if no fires are lighted in them. Air can not be induced to enter a tight room unless some means of escape is given it, and the fireplaces furnish that. The course of the air entering the room from the heating apparatus is to rise to the ceiling and spread out there. It then descends along the sides of the room exposed to the open air, and is withdrawn by the fireplace if there is any which thus serves to facilitate the distribution of the heat in the lower part of the room. If the opening in the chimney is near the ceiling, the warm air will go out there without descending to the floor. It is important, in providing cold-air inlets for any kind of heating apparatus, to see that they take the air from a point where it is pure. They should also take it from the north or northwest, for the coldest winds come from that direction, and the heating of the house at such times is made much more convenient and safe if the prevailing draughts are made to assist it. If the inlets are on the south side of the house, the furnace is liable to be supplied, as is sometimes the case, with air from the northern rooms, entering the house through window-cracks or down a cold chimney, and sending the heated air out through the cold-air box into the back yard. There are limits, and they are not very wide, to the horizontal heating capacity of the best furnaces. Hence, if the ground-plan of the house is extensive, two or more furnaces should be provided rather than to depend upon one. Steam and hot-water apparatus are better horizontal distributors of heat than hot-air furnaces. As between the two, Mr. Philbrick prefers the hot-water apparatus as more easily managed, and more adjustable to mild temperatures, though its first cost is greater than that of steam apparatus. With either, the main dependence for heat should be upon air that has been heated by passing through the apparatus, rather than by direct radiation from pipes or surfaces in the rooms, which should be used only as auxiliaries.

Long Days and Plant-Growth.—The Norwegian plant-geographer, Schübeler, a short time ago called attention to some striking and surprising peculiarities manifested by vegetation in high latitudes, which he ascribed to the intensive light-effects of the long days. Most plants in these regions produce much larger and heavier seeds than in lower latitudes; and the difference is in some cases astonishing. Dwarf beans taken from Christiania to Drontheim gained more than sixty per cent in weight; and thyme from Lyons when planted at Drontheim showed a gain of seventy-one per cent. Grain is heavier in the north than in more southern latitudes; and Norwegian seed planted at Breslau fell off greatly in the first year. Another remarkable fact is that the increase of weight in northern latitudes takes place through the assimilation of non-nitrogenous substances, while the protein products have no part in it. The leaves also of most plants grow larger in high latitudes, and at the same time take on a deeper, darker color. This peculiarity, first noticed by Grisebach and Martins, has been observed not only in most of the wild trees and shrubs, but also in fruit-trees, and even in kitchen-garden plants. It has further been observed that the flowers of most plants are larger and more deeply colored, and that many flowers which are white in the south become in the far north violet.

Brain-Work under Pressure.—A writer in "The Journal of Science," on "Cram and its Amenities," only utters a truism when he remarks that brain-work is not *per se* physically injurious, but that, when kept within reasonable bounds and right conditions, it appears distinctly favorable to health and long life. He enforces the fact by some happy illustrations. An essential condition to the prosecution of brain-work without injury is that the organ must be sufficiently mature before it is subjected to much exertion; hence, it is disastrous to crowd the brains of children. Another important condition under which study is wholesome "is freedom from anxiety, hurry, and worry. This condition is admirably illustrated in the career of almost all great investigators of nature. Woehler (who died at eighty-two), for instance, contributed no fewer than two hundred and twenty-five memoirs to the scientific journals or to the transactions of learned societies. Almost all of these papers are of great value, and many of them embody the outcome of months of careful and delicate experimentation. But in no one case was he compelled to finish any of these researches at a certain date, under appropriate pains and penalties. Precisely the same was the case with Darwin: he was able to pursue his inquiries calmly and dispassionately; able always to take two or three years, if his task could not be finished in one, and in no fear of unpleasant consequences if some idea which he had taken up should lead to nothing. But, if we say to a youth, or, worse still, to a child, 'You must, by a given date, reach a certain standard of knowledge, a certain grade of culture, to be judged of in a summary way . . .,' we place him in the very conditions wherein study becomes unsanitary, even ruinous, and that the more decidedly the more immature the brain." This is the tendency in hosts of schools, where everything is made to depend on examinations, the winning of honors at exhibitions, or on prizes and competitions.

Troubles of a Transfusionist in the Olden Time.—The "Union Médicale" quotes from an old book a curious story of the troubles which beset a physician who experimented in transfusion of blood in the seventeenth century. A Dr. Denys, of Rheims, a strong believer in transfusion, tried that remedy, using calf's blood, with great success, upon a young man whom he found mad in the streets. The patient recovered, and continued well for two months, when he relapsed into dementia. A second experiment worked improvement, but not a cure. The young man soon lost his senses entirely, and his wife brought him again to Denys. A new operation only increased the patient's pains, and he died in a few hours. The widow then brought suit against Denys for killing her husband, and the doctor brought a counter-action against the woman for trying to poison him. The suit went in favor of the woman, but was afterward carried, through a course of appeals, to the Parliament. The case seems ultimately to have been discharged, but an edict was issued forbidding the practice of transfusion, under pain of corporal punishment.

Fertilizers and Savages.—"To what extent is the use of agricultural fertilizers known among uncivilized people?" is one of the questions raised in a paper by Mr. G. Browne Goode, on "The Uses of Agricultural Fertilizers by the American Indians and the Early English Colonists." Mr. Goode finds clear evidence in his historical readings that the Indians of New England used and taught the early settlers to use the menhaden as a manure. The aboriginal name, *munnawhatteaug*, whence our menhaden is derived, means fertilizer, and another name, *paghaden*, is derived from a verb which means to enrich the land. Governor Bradford tells, in his "History of Plimouth Plantation," how the Indian Squanto taught the colonists in planting their corn, that, "excepte they got fish, and set with it (in these old grounds), it would come to nothing." George Mourt, in a journal published in 1622, in speaking of the planting, says, "According to the manner of Indians, we manured our ground with herrings, or rather shads." No other direct reference to its use by Indians is quoted, but several instances are found in which the employment by the colonists of fish for manure is mentioned. Dr. Rau has met with but one allusion to the use of fertilizers by uncivilized races. It is in the writings of Garcilasso de Vega, who mentions the use of guano by the Peruvians. Mr. H. H. Bancroft has found in a translation of the Quiche MS., by Brasseur de Bourbourg, a notice of the Maya custom of cutting and burning the growth on the corn-fields, and allowing the ashes to remain as manure. This, however, was accidental rather than intentional fertilization, as the main object of the burning was to clear away rubbish. Professor Atwater has learned that the Indians of the north shore of Lake Superior use white-fish and lake-trout in manuring their fields, and Mr. Dall says that the Indians of Alaska have learned a rude system of agriculture from the Russians.

NOTES.

H. C. Lewis and G. F. Wright have made a detailed study of the southern boundary of the glaciated area of Ohio, which they find to be sharply defined, though not everywhere marked by such a relative excess of moraine accumulation as in Long Island, New Jersey, and Pennsylvania. The line enters the State from the east in Columbiana County twelve miles north of the Ohio River, runs nearly west into Stark County, where it turns more to the south, and, continuing so to Knox County, it turns then at right angles to the south; thence south and southwest to the Ohio River near Higginsport. "Cincinnati was completely enveloped by ice during the glacial period, and extensive glacial deposits exist in the northern part of Campbell and Boone Counties, Kentucky, and near Aurora, in Dearborn County, Indiana."

THE London "Academy" says that "a duel took place the other day at Pesth between two noblemen, one a son of Count Andrassy, which arose out of a quarrel about the truth of Darwanism. The supporter of Darwinism, we regret to hear, was seriously wounded." From which we may conclude that his opponent now believes in the doctrine of the "survival of the fittest."

DR. A. A. JULIEN, of Columbia College, in a paper on the "Decay of Building-Stones," read before the New York Academy of Science, remarked that the principle that stones are more lasting when laid "on bed" is demonstrated in all the varieties used in building. Defining "life" as the period during which the stone will present a decent appearance, he gave the following as the approximate duration of life of several kinds of stone in New York: Coarse brown-stone, best used out of the sun, from five to fifteen years; laminated fine brown-stone, twenty-five to fifty years; compact fine brown stone, one hundred to two hundred years; Nova Scotia stone, fifty to one hundred years; Ohio sand-stone, the best of the sand-stones, one hundred years; Caen stone, thirty-five to forty years; coarse dolomite marble, forty years; fine marble, sixty years; pure calcareous marble, fifty to one hundred years; granite, seventy-five to two hundred years, according to the variety. Some of the best kinds of building-stone have not yet been brought to the city.

MR. C. J. H. WOODBURY, of Boston, has had sent to him by the Société Industrielle de Mulhouse of Alsace, Germany, its silver prize medal, in recognition of his recent work on the best means of protecting cotton and woolen mills from fire. It is believed that this is the first time an American has been the recipient of this award.

PROFESSOR JOSEPH LE CONTE sums up the conclusions of a paper on the "Genesis of Metalliferous Veins," which is based on the examination of phenomena of metalliferous deposit by solfataric action in Nevada and California, by saying that "subterranean waters of any kind, but especially alkaline, at any temperature, but mostly hot, circulating in any direction, but mainly up-coming, and in any kind of water-way, but mainly in open fissures, by deposit form metalliferous veins. It is evident, therefore, that the form, appearance, and mode of occurrence of veins must be infinitely various, but the mode of formation is substantially one." The study of the varieties of formation may be important to the miner, but is of little value to science proper, except as it illustrates the one principle.

ONE of the finest crinoid beds in the world is at Crawfordsville, Indiana. It is more extensive and affords more perfect specimens than the bed at Keokuk, Iowa. Some of the specimens are twelve inches in length, and several have been sold for eight and ten dollars each. The fossils are imbedded in hard blue clay, and are so brittle that the work of removing them is exceedingly delicate and difficult.

A SUPPOSED stone implement has been found in Philadelphia, in a loose "water-gravel" twenty-four feet below the surface. It is an oblong rectangle in shape, sixteen and a half inches long, nearly four inches wide, and varies in thickness from half an inch at the sides to one and a half inch in the middle. Each extremity is ground to a smooth cutting edge. The specimen is of compact, yellowish-brown sandstone, and is the first that has been discovered in the Philadelphia gravel. If it should prove to belong to the gravel, and to be artificial, it will carry back the antiquity of man to glacial times.

SELECTIVE breeding of fish seems at hand. Seth Green has crossed the striped bass with shad, herring with shad, whitefish with salmon, salmon with brook-trout, and brook-trout with salmon-trout. The last cross is the most successful, and gives fine fish and good breeders. A cross between it and brook-trout promises to make a large trout, suitable for rivers and lakes. Mr. Green purposes next season to produce a seven-eighths brook-trout. He would try a cross between brook-trout and grayling provided both fish spawned at the same time of year, and has hopes of yet securing a cross between the grayling and the California mountain-trout, with which this condition is fulfilled.

CAPTAIN R. N. SCHUFELDT; of the Medical Corps, U. S. Army, has been making a scientific exploration of the vicinity of New Orleans, and has forwarded to the Smithsonian Institution a collection of some three thousand specimens of vertebrates and invertebrates of the region, together with the contents of an Indian shell-mound situated back of Carrollton. Among the vertebrates are some very uncommon forms of bats, and other rare species.

M. CH. MONTIGNY, of Brussels, has observed that the intensity of the scintillation of the stars is greatly increased during the presence of an aurora borealis, and that the increase is more marked in winter than in summer.

INDEX.

PAGE

- Africa, German Explorations in ... 571
- Agricultural Experimental Stations ... 596
- Aims, Higher Professional ... 425
- Air, Liquid, and Solid Alcohol ... 427
- Allen, Dr. Nathan ... 433
- Allen, Professor Grant ... 65
- Americanitis ... 286
- Andrew, Sallie L ... 382
- Animals, How much they know ... 39
- Animals, Vegetating, and Symbiosis ... 811
- Anthrax, Symptomatic, and Disinfectants ... 426
- Armsby, H. P ... 596
- Association, The American ... 858
- Astronomical News, Publication of ... 287
- Astronomy, The Boundaries of ... 94, 239

- Bad Lands, The Little Missouri ... 468, 634
- Baerenbach, Friedrich von ... 195
- Ball, Robert S., F. R. S ... 94, 239
- Bassett, Austin B ... 553
- Bathing, Suggestions about ... 718
- Bayard, Edward, M. D ... 782
- Beard, Dr. George M ... 187
- Bell, Louis ... 536
- Black, J. R ... 698, 845
- Blackwell, E., M. D ... 388
- Bond, A. Curtis ... 475
- Books noticed:
  - "Animal Intelligence" (Romanes) ... 123
  - "Essays in Jurisprudence and Ethics" (Pollock) ... 125
  - "A History of the People of the United States" (McMaster) ... 125
  - "Pharmaceutische Rundschau" (Hoffmann) ... 127
  - "Whence, What, Where?" (Nichols) ... 127
  - "Bulletin of the Archæological Institute of America" (Greenleaf) ... 128
  - "Loess and Associated Deposits of Des Moines" (McGee and Call) ... 128
  - "Papilio" (Edwards) ... 128
  - "A Practical Treatise on Diseases of the Skin" (Duhring) ... 129
  - "A Dictionary of Electricity" (Greer) ... 129
  - "The Storage of Electricity" (Greer) ... 129
  - "On Prehistoric Trephining and Cranial Amulets" (Fletcher) ... 130

Books noticed: PAGE
"The Naval Use of the Dynamo-Machine and Electric Light" (Murdock) ... 130
"The Sociologist" (Chavannes) ... 130
"Journal of Social Science" ... 131
"On the Value of the 'Nearctic,' as one of the Primary Zoölogical Regions" (Heilprin) ... 131
"Report of the Entomologist: Department of Agriculture" ... 131
"Bulletin of the Buffalo Naturalists' Field Club" ... 131
"Exploration of Parts of Wyoming, Idaho, and Montana" (Sheridan). 132
"The Place of Original Research in College Education" (Wright) ... 132
"A Study of the Manuscript Troano" (Thomas) ... 132
"The Elements of Forestry" (Hough) ... 133
"The American Journal of Forestry" (Hough) ... 133
"The Scientific and Technical Reader" ... 134
"Tables for Students and Beginners in Vegetable Histology" (Penhallow) ... 134
"Transactions of the Linnæan Society of New York" ... 134
"Ansichten über die Ursachen der Vulcane" (Reyer) ... 134
"Neptunisch oder Plutonisch?" (Reyer) ... 134
"The Foundation Principle of Education by the State" (Barnett) ... 134
"Forest Protection, and the Tariff on Lumber" ... 135
"Connecticut Agricultural Experiment Station. Report, 1882" ... 135
"Seed-Breeding" (Sturtevant) ... 135
"Development of Mineral, etc., Resources of Colorado for 1881 and 1882" (Smith) ... 135
"The Manual Training-School of Washington University, St. Louis" (Woodward) ... 135
"Dynamic Sociology" (Ward) ... 273
"Man before Metals" (Joly). ... 276
"On the Desert" (Field) ... 277
"Home Gymnastics and Swimming" (Hartelius) ... 278
"The Alternative" ... 279
"Idyls of Norway" (Boyesen) ... 279
"Aboriginal American Literature" (Brinton) ... 279
"Science in Short Chapters" (Williams) ... 279
"Diadem of School Songs" (Tillinghast) ... 280
"Conflict in Nature and Life" ... 416
"Our Home Physician" (Beard) ... 418
"Correspondence of Carlyle and Emerson" ... 418
"Examination of Medicinal Chemicals" (Hoffmann and Power) ... 419
"The Possibility of Not Dying" (Kirk) ... 420
"Bulletin of the United States Fish Commission" (1881) ... 420
"Electro-Magnets" (Du Moncel) ... 421
"A Perpetual Calendar" (Barnard) ... 421
"Pocket Logarithms" ... 421
"Report of the Bureau of Ethnology" (Smithsonian Institution) ... 421
"American Humorists" (Haweis) ... 422
"Jesus, his Opinions and Character" ... 422
"Introduction to the Study of Organic Chemistry" (Pinner) ... 422
"Entomological Papers, Iowa State Horticultural Society" (1882) ... 422

Books noticed: PAGE
"Manual of Assaying Gold, Silver, Copper, and Lead Ores" (Brown). 423
"Experiments with Kerosene on Insects of the Orange-Tree and Cotton-Plant" (Riley)........ 423
"Shade-Trees, Indigenous Shrubs, and Vines" (Stewart)........ 423
"Professional Papers of the Corps of Engineers of the United States Army"........ 423
"Astronomical Papers" (Newcomb)........ 423
"The Bacteria" (Burrill)........ 423
"The Q. P. Index Annual for 1882"........ 424
"Notes of Talks on Teaching" (Parker)........ 559
"Anniversary Address, Class of 1832, Union College" (West)........ 561
"The Life of James Clerk Maxwell" (Campbell and Garnett)........ 561
"Oliver Wendell Holmes, Poet, Littérateur, Scientist" (Kennedy)... 561
"Methods of Social Reform," etc. (Jevons)........ 562
"Inquiries into Human Faculty and its Development" (Galton)...... 562
"Wealth-Creation" (Mongredien)........ 563
"Alcoholic Inebriety, from a Medical Stand-point" (Parrish)........ 563
"Catalogue of Publications of the Smithsonian Institution" (Rhees). 564
"The Leading Men of Japan" (Lanman)........ 564
"The Builder's Guide and Estimator's Price-Book" (Hodgson)....... 564
"First-Year Arithmetic-Teacher's Manual" (Hoose)........ 565
"Astronomy corrected" (Philbrook)........ 565
"Lowest Forms of Water Animals" (D'Anvers)........ 565
"Compendium of the Tenth Census"........ 565
"Geological Survey of New Jersey, 1882" (Cook)........ 565
"Report of the Chief Signal-Officer" (1880)........ 566
"The Jewelers' Circular and Horological Review" (Hopkinson)...... 566
"The Physiology of Protoplasmic Motion" (Englemann)........ 566
"Lectures to the Employés of the Baltimore and Ohio Railroad Company" (Martin, Sewell, Sedgwick, and Brooks)........ 567
"The Unending Genesis" (Simmons)........ 567
"Proceedings of the Davenport Academy of Sciences........ 567
"Proposed Ordinance, Rules and Regulations for Plumbing, in Philadelphia........ 567
"Appalachia," April, 1883........ 567
"Outline of Qualitative Analysis" (Stoddard)........ 568
"The Advanced Question-Book" (Southwick)........ 568
"Parish Institutions in Maryland" (Ingle)........ 568
"Old Maryland Manors," (Johnson)........ 568
"Life of Sir William E. Logan" (Harrington)........ 709
"On Work and Wages" (Brassey)........ 709
"The Religion of Humanity" (Frey)........ 710
"The Cause of Variation" (Curtis)........ 710
"Notes on Evolution and Christianity" (Yorke)........ 710
"Eve's Daughters" (Harland)........ 711
"Legal Provisions respecting the Examination and Licensing of Teachers........ 711
"Bacteria, and the Germ-Theory of Disease" (Gradle)........ 711
"School-Books on Physiology and Hygiene" (Chaillé)........ 712
"The American Trotting-Horse" (Brewer)........ 712

Books noticed: PAGE
"Natural Cure of Consumption, Bright's Disease, etc." (Page) 712
"The Medico-Legal Journal" 712
"Van Loan's Catskill Mountain Guide" 713
"Political Economy" (Walker) 713
"Mastery" 713
"A Visit to Ceylon" (Haeckel) 713
"The Maintenance of Health" (Fothergill) 714
"Descriptive Sociology" (Spencer) 852
"Thermal Springs of the Yellowstone National Park" (Peale) 855
"The Diseases of the Liver" (Harley) 855
"American Museum of Natural History" 855
"Saxon Tithing-Men in America" (Adams) 856
"Medical Economy during the Middle Ages" (Fort) 856
"A Dictionary of Practical Medicine" (Quain) 856
Bosworth, R. S 409
Boundaries, The, of Astronomy 94, 239
Boyesen, H. H 237
Boys, C. Vernon, Esq 365
Brain-Health 572
Brain-Work, On, and Hand-Work 104
Brain-Work under Pressure 862
Bridge, The East River, Constructive Elements of 385
Bridge, The Great, and its Lessons 839
Buchner, Max 399
Burial, A Premature 143
Burmese Animal Life 142
Buttercup, From, to Monk's-hood 65

Cahall, W. C., M. D 86
Campbell, Cl. T 700
Carpenter, F. D. Y 453
Cat-Lore 573
Catskill Mountain-Tops, Vegetation of the 283
Chambers, Prehistoric Underground 570
Channing, W. F., M. D 540
Chase, Pliny Earle 268
Cheesman, James 354
Chemistry and Pharmacy 46
Civilization, Traits of Ancient American 861
Clothing and the Atmosphere 787
Cities, Ancient, in Guatemala 428
Coal, How the Ancient Forests became 56
Cod-Mountain, A, in the Sea 715
Coins, Antique, Baron Stjerstedt's 282
Color-Blindness, Some Peculiarities of 573
Colors, Association of, with Sounds 490
Combustion, Spontaneous 716
Constitutions, Written and Unwritten 267
Consumptives, Florida as a Health Resort for 114
Cookery, The Chemistry of 214, 373, 509, 586, 818

PAGE
Copernicus, Darwin and........ 249
Copyright in China........ 715
Corona, Photographing the........ 285
Correction, A Homœopathic........ 700
Correspondence........ 114, 267, 408, 552, 698, 845
Criticism, A........ 698
Cyclones and Tornadoes........ 748

Darwin and Copernicus........ 249
"Data of Ethics," the, A German View of........ 195
Dawson, Dr. J. W........ 827
De Chaumont, Professor, M. D., F. R. S........ 658
Deep-Sea, A Wonder from the........ 75
Deformities due to School-Life........ 572
De Parville, Henri........ 490
De Saporta, M. G........ 56, 673, 753
Descent, Perrier on the Theory of........ 524
Disease, The Germ-Theory of........ 577
Dix, Dr., on the Woman Question........ 120
Dix, Dr., The Back-down of........ 409
Dog, a Superstitious........ 63
Drunkards? our, What shall we do with........ 140
Du Bois-Reymond, E........ 249
Duncan, John, the Weaver-Botanist........ 717
Dyer, T. F. Thiselton........ 251
Dyspepsia........ 141

Earth, How the, was Peopled........ 673, 753
Earth-Tremors........ 430
Eclipse, The Solar, of May, 1883........ 140
Editor's Table........ 116, 268, 409, 554, 701, 849
Education, Technical........ 475
Electric and Gas Lights, Hygienic Qualities of........ 860
Elephant, The, Mental Capacity of........ 497
Elephants, Intelligence shown by........ 848
English, Teaching........ 553
Espinas, M. A........ 524
Evolution........ 237
Examinations, Cram........ 285

Faculæ and Sun-Spots........ 642
Fangs, False, in Harmless Snakes........ 431
Farr, Dr. William, Sketch of........ 404
Fernald, F. A........ 89, 385
Fire-proof Building Construction........ 613
Fisheries of New York........ 427
Fishes, Musical........ 571
Florida as a Health Resort for Consumptives........ 114
Flowers, The Colors of........ 837
Food, Ways of Preserving........ 623
Foot-Prints, the Nevada, Dr. Harkness on........ 859

PAGE
Forests, North American, The Geological Distribution of 517
Frauenstein, Georg M. 682
Funerals, Chiriqui 716
Funerals, Scotch, in the Olden Time 141
Funeral-Wreaths, Egyptian, restored 284
Furnace, A Smoke-consuming 717
Furnace-heating and Ventilation, Hints on 861

Geology, Some Unsolved Problems in 827
Germ-Theory, The, of Disease 577
Gest, J. Henry 527
Götz, Johannes 88
Gradle, Professor H., M. D 577
Grain-growing, Selection in 354
Greek and Latin against Nature and Science 116
Guatemala, Ancient Cities in 428
Gymnastics 77

Halsted, Byron D., Sc. D 741
Harkness, Dr., on the Nevada Foot-Prints 859
Herbert Spencer and the French Academy 554
Hewitt, Abram S 339
Highway, the Suspended, Opening Day of 411
History, Unwritten 817
Holmes, Dr., The Banquet to 272
Homœopathy and Quackery 847
Homœopathy as a Science 782
Hornaday, William T 497
Howell, Thomas J 517
How much Animals know 39
Huxley, Professor T. H 817
Hygienic Science, The Growth of 658

Iles, George 289
Indians, Brazilian, Capacity of 716
Insanity 627
Insanity, The Prevention of 189
Instinct, Developing a New 552
Instincts, Some Newly Remarked 719
Insurance Management, Improvements in 143
Investigations, Thermo-Chemical, The Aim of 770

Jacobi, Abraham, M. D 773
Jostrow, Joseph 849

King, A. F. A., M. D 644
Krätzer, Dr. Hermann 623

Lamb, R., C. E 54
Lente, Frederick D., M. D 114
Le Sueur, W. D., B. A 444

PAGE
Letter, An Intercepted........ 115
Life, Cost of........ 202, 409
Life, Microscopic, in the Air........ 28
Lightning-Rods........ 429
Literary Notices........ 123, 273, 416, 559, 709, 852
Liver-Fluke, The, of Sheep........ 741
Locusts as Food for Man........ 581
Logan, Sir William, LL. D., F. G. S., Sketch of........ 691
Lovett, Robert W........ 362
Lunt, Horace........ 669
Lyle, David A., U. S. A........ 531

McBride, Professor T. H........ 468, 634
McBride, R. W........ 701
McFarland, R. W........ 409
McGloin, Frank........ 553
Magnetic Storms and Sun-Spots, Recent........ 163
Malaria, Mosquitoes and........ 644
Man, Fossil, in America........ 137
Map-making, Primitive........ 682
Marriage and Divorce Laws, Our........ 224, 663, 701
Matter, Living and Not-Living........ 721
Measures, English and Metric........ 431
Medical Quacks and Quackeries........ 145
Mello, Rev. J. Magens, F. G. S........ 180
Mendenhall, Professor T. C........ 20
Merrick, E. T........ 663
Meters for Power and Electricity........ 365
Microscopy as a Science........ 575
Monk's-hood, From Buttercup to........ 65
Moraine, The Glacial, in Pennsylvania........ 425
Mortality in London and New York, Curves of........ 717
Mosquitoes and Malaria........ 644
Mythology, Our Indian........ 527

Nationalities in New York City........ 569
Natural History, The New York State Museum of........ 139
Nature, The Remedies of........ 1, 187, 303, 477, 604, 760
New England Population, Changes in........ 433
Newton, Heber, and the Heresy-Hunters........ 271
New York City, Nationalities in........ 569
Niagara Falls as a State Park........ 140
Notes........ 144, 287, 431, 575, 720, 863
Nursing, Modern, The Historical Development of........ 773

Olivier, Louis........ 28
One who has been Insane........ 627
Oswald, Felix L., M. D........ 1, 187, 303, 477, 604, 699, 760
Owen, Professor Richard, F. R. S., Sketch of........ 109

Patterson, J. S........ 552

PAGE
Perrier on the Theory of Descent.. 524
Perry, Professor Thomas Sergeant.. 13
Pettenkofer, Max von, Sketch of.. 841
Pharmacy, Chemistry and.. 46
Physics in General Education.. 20
Plant-Growth, Long Days and.. 862
Plants, Insectivorous.. 382
Pluto, The Case of the Dog.. 553
Politics, Modern, The Anarchy of.. 444
Popular Miscellany.............................. 137, 281, 425, 569, 715, 858
Population, New England, Changes in.. 433
Portrait, The First Daguerrean.. 138
Pratt, John.. 202
Prehistoric Underground Chambers.. 570
Progress and the Home.. 412
Psychology, African.. 399
Publications Received.............................. 136, 280, 424, 568, 714, 858
Putnam, Joseph Duncan.. 425

Quartz, its Varieties and Formation.. 180
Quackery, Concerning.. 850

Radau, M. R.. 787
Radiation, On.. 456
Railroad Problem, The, in the United States.. 289
Rank and Title.. 453
Reclamation.. 268
Reis, Philipp, Sketch of.. 540
Remedies, The, of Nature.............................. 1, 187, 303, 477, 604, 760
Remsen, Professor Ira.. 46
Reply, Dr. Oswald's.. 699
Rest, The Right to.. 285
Revenge, Animal.. 283
Rhine, Alice Hyneman.. 408
Ricker, C. J., M. D.. 847
Right-Handed? Why are we.. 86
Ringueberg, Eugene N. S.. 63
R. M. N.. 104
Room enough in the World yet.. 286

Savages, Fertilizers and.. 863
Savings, The, of Science.. 798
Scholarships, The Tyndall.. 412
School-Life, Deformities due to.. 572
Schools and Infectious Diseases.. 429
School-Sessions, Too Long.. 429
Science and Conscience.. 13
Science and Faith.. 281
Science, Literature, and Theology.. 268
Science. Meeting of the American Association for the Advancement of Science at Minneapolis.. 849

	PAGE
Science-Teaching, On, in the Public Schools	207
Scruples, Religious, Satisfying	718
Sea-Sickness, The Cause of	362
Sea-Wall, A Natural	536
Sea-Waves, The Formation of	492
Sedgwick, W. T., Ph. D	811
Serviss, Garrett P	163
Sewage at the Sea-Side	408
Sheep, The Liver-Fluke of	741
Shepherd, Dr. F. J	145
Shipman, Paul R	721
Silliman, Professor Benjamin, LL. D., Sketch of	259
Simmonds, P. L	798
Smell, Insect Organs of	284
Smith, George Clinton	748
Smith, Henry A.	642
Smith, P. C	552
Solar Rays, Machines driven by	337
Sorel, Émile	492
Sounds, Association of Colors with	490, 848
Spectrum, the Visible, Lengthening	88
Spencer, Herbert, and the French Academy	554
Spring, M. W	68
Stammering, Treatment of	138
Starch, The Granule of	687
Stewart, Gordon A	224
Stout, H. R., M. D	848
Street, Charles R	267
Superstition, The Dead-Language	701
Swimming, Position and Stroke in	54
Symbiosis and "Vegetating Animals"	811
Teaching English	553
Telephone, The, with a Sketch of its Inventor, Philipp Reis	540
Tin-Ware, Action of Acids on	571
Thermo-Chemical Investigations, The Aim of	770
Thomsen, Julius	770
Tissandier, G	337
Tobacco Smoke, The Poisons in	427
Tornadoes, Cyclones and	748
Tornado, How to act in a	281
Tracks, Human, More Supposed Pre-Glacial	846
Transfusionist, Troubles of a	863
Trees, The Age of	552
Tyndall, Professor John, F. R. S	456
Vaillant, M. L	75
Vapor, Influence of, on Radiation	287
Vital Phenomena, Two, Explained	575
Vivisection in the State of New York	169
Vogel, August	837

PAGE
Ward, W. E. 613
Water, Aëration of Peaty 860
Water, Getting, in the Desert 426
Water, On the Colors of 68
Weddings, Bedouin 574
Whistling 251
Wilder, B. G., M. D 169
Williams, W. Mattieu 214, 373, 509, 586, 818
Wöhler and "Vital Energy" 553
Woman Question, Dr. Dix on the 120
Women, The Industrial Position of 388
Wonder, A, from the Deep-Sea 75
Woodland and Water-Course 669
Worcester, Alfred, A. M 77

END OF VOL. XXIII.

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Original Communications.

Trichiniasis in its Relation to Public Health and National Economy. By FRANK S. BILLINGS, Vet. Surg., Boston. *Third Article.* American Hogs more infected with Trichinæ than European.—The Disease in Swine, etc.—Professor Ercolani's Recent Investigations of the Anatomy of the Placenta. By HENRY O. MARCY, M. D., Boston (*concluded*).—The Pathology of Acute Lobar Pneumonia from a New Standpoint. By WILLIAM D. SCHUYLER, M. D. *First Article.* An Introductory Summary of the Diverse Views held by Leading Authors as to the Nature of the Disease, etc.

Book Notices.

Wood (G. B.) and Bache (F.). The Dispensatory of the United States. Fifteenth edition, rearranged, thoroughly revised, etc.—Edes (R. T.). Therapeutic Handbook of the United States Pharmacopœia. Being a Condensed Statement of the Physiological and Toxic Action, etc.—Carpenter (W. M.). An Index of the Practice of Medicine.—Books and Pamphlets received.

Leading Articles.

The Proposed State Medical Examining Board.—Life Insurance and the Perils of Childbirth.—The New Quarantine Station on Chesapeake Bay.—The American National Association of the Red Cross.

Minor Paragraphs.

Yellow Fever.—Cholera.—The Sanitary Condition of Philadelphia.—The Boston City Hospital.—Evaporated Milk.—The British Passenger Steamship Medical Service, etc., etc.

News Items.

The Riberi Prize.—Mr. Jonathan Hutchinson, F. R. S.—M. Pasteur's Pension.—M. Pasteur's Cholera Commission.—Dartmouth Medical College.—The Massachusetts Institute of Technology.—The Carney Hospital, Boston, etc.

Obituary Notes.

M. Archambault, of Paris.—Professor Filhol, of Toulouse.—Dr. James Baldwin, of Danbury, Conn.—Bernard G. Semig, M. D., Assistant-Surgeon United States Army.

Proceedings of Societies.

American Ophthalmological Society. Nineteenth Annual Meeting, July 18 and 19, 1883. *Second Day* (*concluded*). Dr. McKay: Sympathetic Neuro-Retinitis occurring during Pregnancy.—Dr. L. Howe: The Difficulties in making a Differential Diagnosis in Glaucoma.—Dr. E. E. Holt: Commotio Retinæ; or some of the Effects of Direct and Indirect Blows to the Eye.—Dr. Charles Stedman Bull: Two Cases of Ophthalmoplegia Externa associated with Disease of the Optic Nerves from Brain Tumor, with an Account of the Post-mortem Examination, etc., etc.—New York Society of German Physicians. Meeting of October 27, 1882. Dr. H. Knapp: Removal of an Aneurysmal Tumor of the Orbit.—Dr. A. Fridenberg: Cavernous Angioma of the Tongue, etc., etc.—Obstetrical Society of Philadelphia. Meeting of March 1, 1883. Dr. W. Goodell: Double Enucleation of Uterine Fibroids.—Dr. B. F. Baer: Induction of Premature Labor for the Relief of Suppression of Urine.—Dr. D. F. Willard: Induced Premature Labor for Great Œdema of the Labia Minora.

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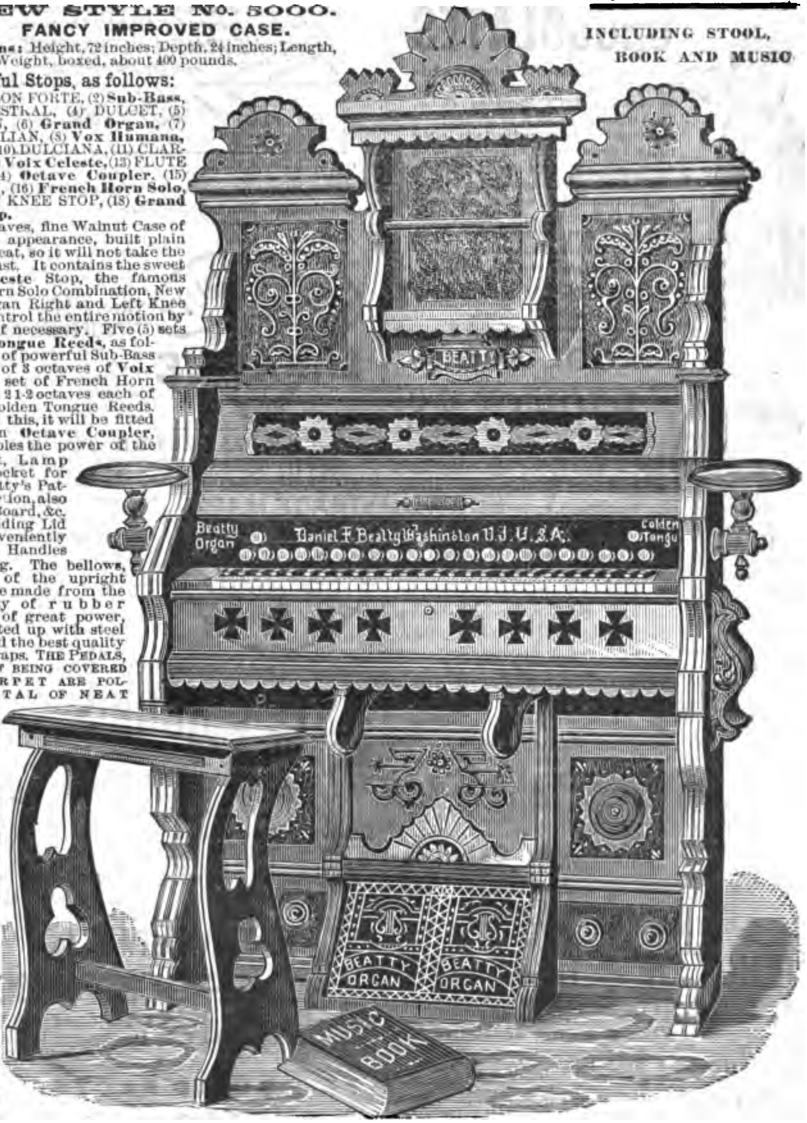

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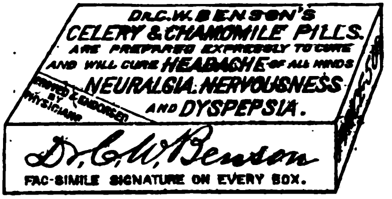

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JANUARY 1, 1883.

Amount of Net Cash Assets, January 1, 1882 .... **$45,130,006.86**

REVENUE ACCOUNT.

Premiums	$9,604.788.38		
Less deferred premiums January 1, 1882..	452,161.00—	$9,152,627.88	
Interest and rents (including realized gains on real estate sold).............	3,089.273.21		
Less interest accrued January 1, 1882..	291,254.80—	2,798,018.41—	$11.950,645.79
			$57,080,652.65

DISBURSEMENT ACCOUNT.

Losses by death, including Reversionary additions to same........................		$1,955,292.00	
Endowments matured and discounted, including Reversionary additions to same.......		427,258.95	
Annuities, dividends, and returned premiums on cancelled policies..................		3,827.758,76	
Total paid Policy-holders	$6,210,309.71		
Taxes and re-insurances..		234.678.27	
Commissions, brokerages, agency expenses, and physicians' fees......................		1,332.038.38	
Office and law expenses, salaries, advertising, printing, etc		385,111.18—	$8,162,187.54
			$48,918,515.11

ASSETS.

Cash in bank, on hand, and in transit (since received).	$1,276,026.67	
Invested in United States, New York City, and other stocks (market value, $19,953,956.52)	18,072.074.81	
Real Estate.	4.123,065.18	
Bonds and mortgages, first lien on real estate (buildings thereon insured for $17,950,000.00 and the policies assigned to the Company as additional collateral security)..........	19,306.940.16	
Temporary loans (secured by stocks, market value, $5,191,189.50)	4,813,003.00	
* Loans on existing policies (the reserve held by the Company on these policies amounts to $2,690,961)	494,082 23	
* Quarterly and semi-annual premiums on existing policies, due subsequent to Jan. 1, 1883	540,555.91	
* Premiums on existing policies in course of transmission and collection.................	394 385.19	
Agents' balances	62,424.95	
Accrued interest on investments January 1, 1883..	326,000.06—	$48,918,515.11
Excess of market value of securities over cost..		1,881,881.71

**A detailed schedule of these items will accompany the usual annual report filed with the Insurance Department of the State of New York.*

CASH ASSETS, January 1, 1883, - $50,800,396.82

Appropriated as follows:

Adjusted losses, due subsequent to January 1, 1883......		$351.451.21
Reported losses, awaiting proof, etc....		138,970.23
Matured endowments, due and unpaid (claims not presented)..........................		58,850.43
Annuities, due and unpaid (uncalled for)..		6,225.86
Reserved for re-insurance on existing policies; participating insurance at 4 per cent. Carlisle net premium: non-participating at 5 per cent. Carlisle net premium........		43,174,462.78
Reserved for contingent liabilities to Tontine Dividend Fund, January 1, 1882, over and above a 4 per cent. reserve on existing policies of that class....	$2,054,244.03	
Addition to the Fund during 1882 for surplus and matured reserves.........	1,109,966.00	
	$3,164,210.03	
DEDUCT—		
Returned to Tontine policy-holders during the year on Matured Tontines...	1,072,837.87	
Balance of Tontine Fund January 1, 1883		2,091.372.16
Reserved for premiums paid in advance.		35,782.36
		$45,851,555.03

DIVISIBLE SURPLUS at 4 per cent **4,948,841.79**
Surplus by New York State Standard at 4½ per cent., estimated at............ **10,000,000.00**

From the undivided surplus of $4,948,841 the Board of Trustees has declared a Reversionary dividend to participating policies in proportion to their contribution to surplus, available on settlement of next annual premium.

During the year 12,178 policies have been issued, insuring $41,325,520.

Number of Policies in Force.	Amount at Risk.	Death-claims Paid.	Income from Interest	Divisible Surplus at 4 per cent.
Jan. 1, 1879..45,005.	Jan. 1, 1879...$125,232,144.	1878.....$1,687,676.	1878.....$1.948,665.	Jan. 1, 1879..$2,811.436
Jan. 1, 1880..45.705.	Jan. 1, 1880... 127,417.763.	1879 .... 1.569,854.	1879..... 2.039,650.	Jan. 1, 1880.. 3,120.371
Jan. 1, 1881..48,548.	Jan. 1, 1881... 135.726.916.	1880..... 1.731.721.	1880..... 2.317,589.	Jan. 1. 1881.. 4.295,096
Jan. 1, 1882..53,927.	Jan. 1, 1882... 151,760,824.	1881 .... 2,013.203.	1881..... 2.432.654.	Jan. 1, 1882.. 4,827.036.
Jan. 1, 1883..60,150.	Jan. 1, 1883... 171,415,097.	1882..... 1,955,292.	1882..... 2,798,018.	Jan. 1, 1883.. 4,948,841.

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